ORGANIZATION FOR AGRICULTURAL RESEARCH AND PROBLEMS UNDER INVESTIGATION

Forty-Fifth Annual Report
of the
Montana Agricultural Experiment Station
July 1, 1937 to June 30, 1938

MONTANA STATE COLLEGE
AGRICULTURAL EXPERIMENT STATION
BOZEMAN, MONTANA

FOREWORD

Every taxpayer is entitled to a clear understanding of the organization and responsibilities of the various public agencies which are financed by his tax dollar. No public agency can perform its functions properly nor win the degree of support to which it is entitled unless the tax-paying public understands and fully appreciates the nature of the organization and makes liberal use of the services which it is prepared to render.

In each state of the United States, there is at least one State Agricultural Experiment Station, which is associated with the State College of Agriculture and Mechanic Arts, made possible by the First Morrill Act of 1862.

In a state like Montana where agriculture is the principal source of new wealth, each year a large part of the population should be concerned, either directly or indirectly, with the organization provided to conduct agricultural research or investigations, and the contributions which the Agricultural Experiment Station is prepared to make toward the solution of the problems with which an ever-changing agriculture is always confronted.

Because agriculture is a basic industry in Montana and is the largest single source of new wealth every year, each citizen of this State should have a personal interest in the Montana Agricultural Experiment Station—should regard it as *his or her* Agricultural Experiment Station. Each citizen should know that the Agricultural Experiment Station is a fact-finding agency—one which conducts exhaustive and impartial investigations into agricultural problems, in order to obtain reliable, factual information on which more permanent and profitable types of agriculture may be established.

Each citizen should know that the Agricultural Experiment Station has no selfish interest to serve and, therefore, is obligated to provide only those interpretations of research which may be conclusively supported by the facts at hand.

ORGANIZATION FOR AGRICULTURAL RESEARCH AND PROBLEMS UNDER INVESTIGATION

By

Clyde McKee, Director

FOUNDATION AND PLAN OF THE MONTANA AGRICULTURAL EXPERIMENT STATION

During the early history of the United States, the Federal Government committed itself to the policy of transferring its vast land resources from public ownership to private ownership as rapidly as possible. Through the passage of the various Homestead Acts and Land Grants, Congress encouraged the settlement and development of large areas of land for agricultural purposes. A rapidly expanding agricultural industry in a new country soon gave rise to many questions—questions for which there were then no answers.

Recognizing that agriculture would develop very slowly at best, in a wholly unknown environment, farmers with a vision proposed a nation-wide system of investigation or research primarily for the benefit of those who were to occupy the land. After careful deliberation, Congress, in 1887, approved the Hatch Act authorizing the establishment in every state and territory of at least one experiment station—"to aid in acquiring and diffusing among the people of the United States useful and practical information on subjects connected with agriculture, and to promote scientific investigation and experiment respecting the principles and applications of agricultural science."

The Legislature of the State of Montana accepted the provisions of the Hatch Act and in 1893, authorized the establishment of the Montana Agricultural Experiment Station, with headquarters at Bozeman in connection with Montana State College. Thus in June 1938, this Station completed its 45th year of service through research to the agriculture of Montana. During this period of 45 years, the Experiment Station organization has been expanded or

modified to meet some of the most urgent needs of farmers and stockmen, and to cope with a few of the more pressing problems of a rapidly changing agriculture.

The headquarters of the Montana Agricultural Experiment Station are at Bozeman, and here are also located thirteen research and service departments, each charged with separate and distinct responsibilities. These departments at Bozeman are a clearing house for research which is carried on everywhere in the State, and thus they serve as the leaders of agricultural research and services for the entire State. In the following pages, the heads of the various departments and the Branch Stations have outlined the functions of research for which each is responsible and have listed current research projects and their objectives.

DEPARTMENTS AND ACTIVITIES AT BOZEMAN

DEPARTMENT OF AGRICULTURAL ECONOMICS

By

R. R. Renne

Functions of the Department

In Montana, the function of the Department of Agricultural Economics is to investigate the economic and social problems of agriculture. The present work of this department includes (1) farm and ranch organization and management, both with and without irrigation, (2) land economics, (3) agricultural marketing, (4) land utilization, (5) agricultural prices and outlook, (6) farm credit and taxation, and (7) rural sociology. Collecting and analyzing economic and sociological information which is basic to successful agriculture in a commercialized society and better home living on Montana farms and ranches is the goal of economic activity.

The research work in agricultural economics involves four principal steps; namely, (1) preparation of an inventory of the nature and scope of the economic problems affecting Montana's agriculture, (2) collection of data which are applicable to local and State conditions so that the results of research are more pertinent to specific areas, (3) analyzation and intepretation of the

data so that significant cause and effect relationships may be uncovered, and (4) presentation of the results of research in a manner as effective as possible for general use by farmers and agencies associated with agricultural programs and development.

Changes occurring during and since the World War have necessitated major changes in research in agricultural economics. During recent years, the Montana Station has devoted considerable attention to studies in land utilization and land tenure, farm taxation, farm credit, and agricultural marketing—problems which require group action for their solution rather than the efforts of the individuals. Thus, much recent research has been of a type calculated to be helpful to various groups, both public and private, which are concerned with the State's agricultural problems. The trend toward extreme specialization and commercialization in recent years has resulted in external forces outside of the farm fences becoming of primary importance. Problems have been created which are vital to individual farm and ranch operators, but which up to the present time are relatively foreign to their understanding. Thus, it becomes necessary for a department concerned with economic and sociological problems to collect, interpret, and disseminate information of a broader nature than the more specific farm management type of data of earlier years.

The fundamental objectives of a modern Department of Agricultural Economics might be grouped under the following heads: (1) creation of a more general understanding of the effect of external economic forces upon agriculture (tariff, industrial price policies, government control policies, etc.); (2) development and dissemination of farm organization and management techniques by which the individual operator, or operators acting in groups, may make the most intelligent adjustment to the problems with which they are confronted. In connection with this latter objective, specific farm and ranch management and cost studies will still be essential and considerable work should be done on these phases, but in addition, present day research in agricultural economics should also give considerable time and thought to the larger economic and sociological forces whose impact upon agriculture has brought about so much chaos, confusion, and distress during recent years.

Active Projects and Their Objectives

The general objectives of the research program of the Department of Agricultural Economics are being achieved through a group of active projects or lines of investigation. These projects with specific objectives are as follows:*

Agri. Econ. 39—An Economic Analysis of Livestock Marketing:

1. What is the most profitable market for various kinds of

*Departmental projects are numbered consecutively. Missing numbers indicate projects on which work has been completed or suspended.

Montana livestock (a) during rising price periods, (b) during falling price periods, and also (c) within seasons during the year?

2. What are the most profitable grades and classes of livestock for Montana Producers in various markets and marketed in different seasons of the year?
3. What is the relationship between shrinkage or net yield of carcass or grade of carcass of different types of livestock and various feed rations and marketing methods?
4. Are the most profitable feed rations and marketing practices those which are currently being used by feeder operators?

Agri. Econ. 48—*Economic Trends in the Livestock Industry of Montana*:

1. What are the principal causes for the wide fluctuations in range cattle and sheep numbers in Montana over a period of years?
2. What is the relationship between fluctuations in range cattle and sheep numbers in Montana to national supply and quality of beef and sheep supplies, demand, price and related data?
3. What shifts in range cattle and sheep have occurred and are now in process of occurring between counties and areas within the State?
4. What local forces have been operating in changing livestock numbers in the State?
5. What are the possible effects of these forces on the economic utilization of the agricultural resources of the State?

Agri. Econ. 51—*Types of Farming in Montana*:

1. What different types of farming are practiced in Montana, and what are boundaries of such type-of-farming areas?
2. What combination of enterprises and what farming practices are in operation in each of these different type-of-farming areas?
3. What are the average gross incomes or receipts of farmers operating in the different type-of farming areas, and what is the distribution of such income?
4. What type-of-farming areas seem to have the largest proportion of farmers in the very low income groups and which in the highest, and what essential factors are associated with this grouping?
5. What changes in land use and farm practices have occurred in recent years, and what seem to be the present and probable future trends in these areas?
6. What kinds of adjustment programs are best fitted to improve the economic condition of farm operators in the differ-

ent type-of-farming areas, and how can such adjustment programs be most effectively put into operation in these different type-of-farming areas?

Agri. Econ. 53—*An Analysis of Farm Organization on Non-Irrigated Land*:

1. How have farm practices in Montana been affected by recent farm programs, particularly that of the A. A A.?
2. How have these farm programs affected the size of farms, the amounts of labor and capital employed, and the types and combinations of enterprises used?
3. How has the limitation of acreage by the A. A. A. affected the operating farm income and farm organization in Montana's small grain producing areas?
4. Have the adjustments which have been brought about by the A. A. A., Soil Conservation, and related action programs been in close harmony with adjustments which should be brought about to better adapt the utilization pattern to the physical resources of the different areas of the State?

Agri. Econ. 54—*Analysis of Possible Coordination of Land Resources in Montana*:

1. What is the best system of agriculture both from the economic and social standpoint for each of the different type-of-farming areas in Montana?
2. How can the best system of agriculture for the different areas of the State be established?
3. What standards should be established for determining the most economical combination of dry farming and grazing land with irrigated lands in different sections of the State?
4. On the basis of inventories of physical resources and institutional patterns superimposed on such resources, what types of public control of use of agricultural land are best fitted to serve Montana's agriculture (this deals with the related merits of such proposals as land use zoning, soil conservation districts, etc.) ?

Agri. Econ. 55—*Recent Changes and Present Organization of Agricultural Finances*

1. What is the relationship between important economic factors such as soil types and grades, types of farming, size of farm units, period of the business cycle and other factors to the amount and type of farm indebtedness?
2. What have been the lending policies of various financing agencies, and what have been their comparative records of successful loan experience?
3. To what extent have government loan agencies participated in agricultural credit to relieve other lenders and to save farmers from losing their farms?

4. What is the size of the interest burden which farmers pay on borrowed funds to operate their business?
5. Why do farmers borrow, and what is the usual record of loans made to farmers?
6. Have Montana farmers over-borrowed, or is the farm mortgage indebtedness of many Montana farms in excess of the income yielding ability of the land based upon average expected farm prices and quality of the soil?
7. What kinds of debt adjustment programs will be necessary in years ahead to best serve the State's agricultural credit needs?

Agri. Econ. 57—*Factors Relating to Farm Organization on Irrigated Land in Montana*:

1. What are the effects of location, soil types and grades, yields, water and other factors on the most economic size of irrigated farm units and on irrigated farm operation?
2. What is the best combination of enterprises under various conditions of irrigation to secure the highest net farm profits?
3. What does it cost in terms of cash outlay to produce the major farm crops on irrigated land in various areas of Montana?

Agri. Econ. 58—*Economic Limits of Cost of Water for Irrigation*:

1. How much can Montana farmers afford to pay for water to produce specific crops in different types of farming areas in Montana?
2. Are taxes, debts, and other overhead items proportionately more out of line on Montana irrigated farms than on non-irrigated farms and range units?
3. What are the present methods of utilizing irrigated lands and which practices seem to be most effective in the different farming areas?
4. What standards are most effective in determining the feasibility of proposed irrigation projects?
5. What economic problems seem to be most closely associated with irrigation development in the different irrigated areas of the State?
6. What kinds of adjustments and economic programs are essential to solving the major economic problems facing irrigated farming in Montana?

Agri. Econ. 59—*Inventory of Montana's Irrigable Land Resources Available for Settlement of Stranded Farmers*:

1. Where are Montana's irrigable lands located, and what is their present condition?
2. What are the overhead costs, particularly of water and taxes, in various irrigable areas of the State?

3. What opportunities exist regarding availability of land suitable for production of certain crops, cost of production, net farm profits and economic size of farm operating units for the various irrigable areas of the State?
4. How many stranded Montana farm families can be settled to advantage in different irrigable areas of the State?

Agri. Econ. 61—*Possible Farm Tax Reductions Through Reorganization of State and Local Government*:

1. What changes could be made in the forms, methods and functions of the country and State governments in Montana to reduce the costs of such governments?
2. How much could farm taxes be reduced by each of a number of proposed specific changes in the organization and administration of county and State governments?
3. What changes in methods of supporting certain public services, particularly schools, would be most productive in reducing the farm tax burden without at the same time reducing the quality of educational services and the democratic control of our schools?

Agri. Econ. 64—*Possible Future Changes in the Operation of Soil Conservation and Domestic Allotment Act.*

(Sub-Project: A Study of Possible Applications and Procedures in the Operation of the Soil Conservation and Domestic Allotment Act Relative to Range Lands and Livestock.)

1. What have been the effects of the Range Conservation Program (A. A. A.) upon the range practice in Montana?
2. Have recent action agency programs resulted in carrying out certain livestock and range land management practices which are conducive to an improvement in the grass cover and the retarding of soil erosion?
3. Are Montana livestock numbers increasing to a point where they will exceed the recommended safe carrying capacity of our range lands?
4. What range areas in Montana seem to be the most overstocked, and in which areas are adjustments encouraged by recent action agency programs being worked out most effectively?

Agri. Econ. 66—*Analysis of Montana Farm Taxation and Related Finance Aspects of Agricultural Adjustment Programs*:

1. How much of Montana's agricultural land is delinquent in tax payments for one, two, three and five or more years, and where in the state is this land located?
2. How many and which acres of agricultural lands in Montana have reverted to public ownership through tax delinquency, and how many and which acres are now subject to tax deed?

3. What are the principal causes for the record of tax delinquency and tax reverted lands in Montana?
4. Are Montana lands assessed according to their true productivity value based on a scientific soil classification and average yield and prices? If not, what types and grades of land seem to be the most overassessed and which the most underassessed and why?
5. How does the tax burden carried by Montana farmers compare with that carried by other occupational classes in Montana in terms of the ratio of total taxes paid to net income?
6. What are the principal effects of various agricultural adjustment programs, including Federal land purchase, on local government tax receipts and the cost of rendering various local services?

Agri. Econ. 67—Rural Social Conditions and Trends in Montana:

1. How many Montana farm families have moved out of certain areas, and how many have moved into other areas in the State?
2. What kind of families seem to move most, and what effect has such farm population mobility on the community from the standpoint of number and kinds of families remaining and age of population remaining?
3. Do migratory farm families move outside of the State or do they move to other areas in the State?
4. What is the earning power and general economic condition of the resettled farm families?
5. How much is being spent by emergency agencies annually within Montana, and what are the trends and contributions of each of these emergency agencies?
6. What proportion of the farm population is securing assistance from emergency agencies, and how effective in rehabilitating the needy farm population of the State is the public assistance that is being secured?
7. What are the working conditions, income earned, and general economic condition of certain types of farm laborers in Montana, including sugar beet workers?

Agri. Econ. 68—Public Policy on Conservation and Management of Grazing Lands in Montana:

1. What are the relative advantages of grazing control and management of the range through cooperative grazing districts, individual ranches, and public and quasi public agencies?
2. What types of grazing control and range management seem to be working out most effectively in securing the proper adjustment of livestock numbers to grazing resources?

3. What polices and procedures are being followed regarding grazing permit distribution and range land utilization by the different individual and group agencies that are handling grazing lands?
4. What effect will the recent developments in grazing control and management have upon the income and ranch organization of individual operators?
5. How can policies of permit distribution and range management of the different agencies be coordinated to realize the best use inter-relationship between different types of land under control by various agencies operating in the same area or in contiguous areas?
6. How can lease rates and grazing fees be established both in amount and flexibility to meet changing conditions from year to year to avoid an undue overcapitalization in ranch property values or to avoid public subsidizing of grazing units?

DEPARTMENT OF AGRONOMY

By

A. H. Post

Functions of the Department

Agronomy is that branch of agriculture which deals with the theory and practice of field crop production and soil management. In Montana, it is the duty of the Agronomy Department (1) to survey and classify the soils of Montana, thus providing an inventory of the soil resources of the State and furnishing the fundamental data for a sound program of land use, (2) to determine the adaptability of cereal and forage crops to Montana's soil and climatic conditions, (3) to produce improved varieties of field crops by hybridization and selection, (4) to determine suitable cropping systems and rotations for both irrigated and non-irrigated farm lands, (5) to determine the value of various grasses and legumes for irrigated and non-irrigated pastures and for reseeding abandoned crop land, (6) to determine suitable cultural methods for the preparation and care of summer fallow and for general crop production, (7) to develop methods of maintaining soil fertility, (8) to determine the most practical methods of controlling and eradicating noxious weeds, and (9) to determine the methods of crop production and soil management which are most effective in conserving both water and soil.

Active Projects and Their Objectives

Agron. 3—Crop Rotations for Irrigated Land:

1. To determine the value of different methods of cropping irrigated land to maintain productivity of the soil.

2. To determine the effect of different methods of cropping upon the yield and quality of crops.
3. To determine the effectiveness of different crop rotations for the control of weeds, especially the perennial varieties.

Agron. 33—Miscellaneous Tests:

1. To obtain preliminary information regarding new crops or varieties, new methods of seed and soil treatment, etc.
2. A means of initiating preliminary studies which at the outset are not of sufficient importance to warrant investigation under special or separate projects.

Agron. 73—The Comparative Yield and Quality of New and Standard Varieties and Strains of Alfalfa:

1. To determine the varieties of alfalfa which are best adapted for the production of hay on irrigated land.
2. To determine the winter hardiness of domestic and imported strains of alfalfa as a protection to Montana alfalfa growers.
3. To determine the quality of different varieties of alfalfa, as measured by protein content and leafiness.

Agron. 73—Flax Varieties in the Gallatin Valley:

1. To compare different varieties of flax for production on irrigated land in the Gallatin Valley and other similar mountain valleys of the State.
2. To develop improved varieties of flax by hybridization and selection.

Agron. 84—Soil Reconnaissance of Montana:

1. To survey and map the various soil types of an area, thus contributing to an inventory of the soil resources of the State.
2. To assist in classifying farm land and grazing land on the basis of productivity.

Agron. 85—Detailed Soil Survey:

1. To make detailed surveys of the soils of irrigated or irrigable areas and map the various soil types.
2. To assist in classifying irrigated and irrigable land on the basis of productivity.

Agron. 98—Cooperative Nursery Trials:

To conduct cooperative nursery trials in various counties of the State to supplement the information obtained by the Experiment Station on the adaptation and value of promising new crop varieties.

Agron. 99—Factors Affecting the Quality of Wheat and Flour for Milling and Baking:

1. Effect of various factors on the quality of wheat for milling, including light weight and frosted wheat.
2. Effect of various factors on the quality of flour for baking, with special emphasis on light weight and frosted wheat.

Agron. 102—Date of Seeding and Methods of Treating Wheat to Control Smut:

1. Effect of date of seeding on smut control.
2. Comparison of various chemical treatments for treating wheat for smut control.

Agron. 105—Factors Which Determine the Effectiveness of Calcium and Sodium Chlorate for the Control of Perennial Weeds:

1. To determine most effective methods of using calcium and sodium chlorate to control perennial weeds.
2. To determine the influence of soil moisture, atmospheric temperatures, season of year, strength of chemical solution, and stage of plant growth upon the efficiency of chlorates used for weed control.

Agron. 110—Production of Foundation Seed Stocks of Standard Varieties of Small Grains and Flax for Distribution to Farmers:

To provide a dependable source of foundation seed stocks of standard varieties of small grains and flax that are adapted to and recommended for Montana.

Agron. 113—Winter Wheat Variety Testing in Field Plots:

1. To determine varieties or strains of winter wheat best adapted to commercial production under soil and climatic conditions similar to those prevailing in the Gallatin Valley.
2. Varieties are compared as to yield, quality for milling and baking, winter hardiness, disease resistance, etc.

Agron. 114—Hybridization and Selection of Winter Wheat Varieties to Obtain Improved Strains:

Breeding and selection to produce strains of winter wheat for Montana which are superior in winter hardiness, resistance to bunt or stinking smut, stiffness of straw, yield, and in baking quality.

Agron. 115—Standard and New Varieties and Strains of Winter Wheat Tested in Smut, Hardiness and Yield Nurseries:

1. Promising varieties and strains of winter wheat are tested in smut, hardiness, and yield nurseries.

2. Useful as a source of parent material possessing resistance to smut, winter hardiness, high quality and capacity for high yield, to be used in a wheat breeding program.

Agron 116—Spring Wheat Varieties Grown in Field Plots to Determine Their Adaptability to Production under Irrigation:

1. To determine which varieties or strains are best adapted to commercial production under irrigation.
2. Varieties compared as to disease resistance, quality for milling and baking, date of maturity, stiffness of straw, and yielding capacity.

Agron 117—Hybridization and Selection of Spring Wheat Varieties to Combine Desirable Agronomic and Quality Characteristics:

1. Breeding to produce a superior variety of spring wheat for Montana's high-quality wheat areas.
2. Attempting to combine in one variety or strain certain desirable qualities including resistance to rust and smut, early maturity, stiffness of straw, good baking quality and high yield.

Agron. 118—Standard and New Varieties of Spring Wheat Grown in Disease and Yield Nurseries:

1. Promising varieties and strains of spring wheat tested in uniform nurseries in seven states under a cooperative agreement between the states and the United States Department of Agriculture.
2. Useful as a source of parent material possessing resistance to diseases and capacity for high yield, to be used in a wheat breeding program.

Agron. 119—Field Plot Testing of Standard and New Varieties of Oats for Production on Irrigated Land:

1. To determine the adaptability of carefully selected varieties and strains of oats for production under irrigation.
2. To compare varieties as to earliness, stiffness of straw, and yielding capacity.

Agron. 120—Improvement of Oats by Hybridization and Selection:

1. To develop superior new oat varieties from standard varieties now available through hybridization and selection.
2. To obtain a variety which combines earliness, stiffness of straw, freedom from disease, white grain, high test weight and capacity for high yield.

Agron. 121—Testing Barley Varieties for Production on Irrigated Land:

To determine the relative merits of standard and new varieties of both feed and malting barley when grown under irrigation.

Agron. 122—Improvement of Barley by Hybridization and Selection:

1. To improve standard and new varieties of barley by hybridization and selection.
2. Attempting to combine in one variety, high yield, high test weight, and stiffness of straw along with yellow or white endosperm.

Agron. 123—Availability of Phosphorus in Calcareous Soils as Measured by Chemical and Biological Methods:

1. To determine the influence of calcium carbonate (lime) on the availability of phosphorus to plants.
2. To obtain information relative to the method of using different kinds of phosphatic fertilizers, especially on the high-lime soils characteristic of many parts of Montana.

Agron. 124—Production of Crested Wheatgrass Seed under Irrigation:

To determine the seed producing possibilities of crested wheatgrass on irrigated land and the effects of rate and method of seeding on seed yields.

Agron. 125—Alfalfa Improvement by Breeding and Selection:

1. To obtain strains of alfalfa for Montana superior to those now available in leafiness, cold resistance, wilt resistance, and in yield of hay and seed.
2. To select hardy plants from old established fields and to produce new strains by hybridization and selection.

Agron. 126—Corn Improvement through the Development and Use of Inbred Lines:

1. To produce strains of corn superior to the present open-pollinated varieties in yield of grain and fodder through hybridization of inbred lines.
2. To test hybrid corn varieties now available on the market for adaptation and breeding possibilities.

Agron. 127—Life History of Hay and Pasture Grasses and Modifications Induced by Change in Environment:

1. To study the life history of *Bromus Tectorum* and the variability within the species.
2. To study the effects of light and iarovization on several species of grass.

3. To evaluate environmental changes including the seed and forage producing ability of various species of grasses under different conditions.

Agron. 128—Adaptation Tests of Domestic and Foreign Species, Varieties and Strains of Grasses in Different Environments:

To conduct adaptation tests on bulk species and improved strains of promising grasses at the various Branch Experiment Stations and in cooperation with county agents through the State.

Agron. 129—Selection and Hybridization for the Improvement of Hay and Pasture Grasses:

1. To improve certain species of grass through hybridization and selection.
2. To isolate genetic types in certain grasses by selfing and close line breeding.

DEPARTMENT OF ANIMAL HUSBANDRY

By

R. T. Clark

Functions of the Department

The Animal Husbandry Department is responsible primarily for researches into the problems of animal breeding, feeding and management. Since July 1, 1938, the research work of this department has been concentrated on beef cattle, sheep, and swine, with greater emphasis on the first two classes of livestock. In the field of livestock management, the Animal Husbandry Department is conducting investigations pertaining to the utilization of grazing lands and the management of range livestock.

A beef cattle herd of approximately 675 to 725 head of high quality Herefords, maintained at the U. S. Range Livestock Experiment Station, and a cow herd of approximately 150 head of Herefords, maintained at the North Montana Branch Station, enable the Animal Husbandry Department to undertake breeding and management experiments in cooperation with the Bureau of Animal Industry of the U. S. D. A. These investigations are designed to assist the cattlemen operating on short-grass ranges as well as those situated to combine winter operations on the home ranch with summer grazing in private or national forests.

A cooperative agreement with the U. S. Forest Service and recent consolidation of grazing lands under lease to the Agricultural Experiment Station in conjunction with the Fort Ellis Sheep Farm near Bozeman enables the Animal Husbandry Department to conduct a rather extensive sheep breeding project, and at the

same time, gather data on the effect of different systems of grazing on the recovery of the vegetative cover on range previously subjected to serious abuse.

With excellent facilities for handling research with beef cattle and sheep, the Animal Husbandry Department is working on the practical problems which confront the producers of livestock operating under both farm and ranch conditions in this State.

Active Projects and Their Objectives

A. H. 29—Miscellaneous Observation:

A blanket project to cover all research activities not included under formal projects.

1. Cooperation with a large sheep ranch in Beaverhead County to determine the relative merits of grain pellets and cottonseed meal pellets as a supplement for ewes wintering on the range.
2. Cooperation with lamb feeders in the Sidney area to determine (a) relative merits of various rations from the standpoint of amount and efficiency of grains, market shrink, net carcass yield, and carcass grades of the lambs fed, and (b) relative merit of various rations and selected marketing practices for both the commercial feeder and the packer. (Assisted by Department of Agricultural Economics.)
3. Cooperation with lamb feeders in the Billings and Hardin areas to determine (a) efficiency and suitability of various rations for fattening lambs, and (b) feed lot and marketing practices best adapted to those areas.

A. H. 50—Methods of Utilization of Grazing Lands by Range Sheep:

Grazing on private lands held under lease and on National Forest allotment under permit according to definite systems or schedules worked out cooperatively by the Animal Husbandry Department and the Forest Service

1. To develop methods of obtaining full utilization of grazing lands by range sheep without injury to the forage thereon.
2. To build up greater productivity or carrying capacity of ranges depleted through abuse.
3. To observe effects of tepee system of herding in which the bed ground is changed each night.
4. To determine effects of once-over system of grazing with twice-over system, on both the sheep and the vegetative cover of the range.

5. To determine the effects of deferred grazing of badly depleted grazing land on reseeding and restoration of the native vegetative cover.

A. H. 63—Feeding Beet By-products to Lambs to Determine the Most Practical Ration When Fed with Alfalfa and Grain of Various Kinds:

1. To determine most practical rations with and without beet by-products for fattening lambs in the irrigation areas.
2. To compare the merits of self-feeding and hand-feeding the grain ration when fattening lambs.
3. To determine the effectiveness of self-feeding a ration of oats and dried molasses beet pulp when mixed with chopped hay.

A. H. 65—Minerals and Tankage for Fattening Fall Pigs on Grain:

During the past year, the objective has been to determine the relative feeding efficiency of different litters of pigs when fed upon the same ration of barley, tankage and bone meal.

A. H. 72—Fattening Calves on Small Grain and Alfalfa Hay:

1. To determine the relative fattening ability of small and large type steers.
2. To determine the suitability of a grain ration consisting of one-half dried molasses beet pulp and one-half ground barley and a ration consisting of one-fourth molasses beet pulp and three-fourths ground barley.
3. To obtain a record-of-performance of steer calves of known ancestry from grade Hereford cows and purebred Hereford bulls through individual fattening experiments.

A. H. 77—Progeny from Large Type Beef Sires Compared with Those from Smaller, More Compact Type of Sires When Developed under Different Planes of Nutrition for Use on the Range:

1. To determine whether the large, heavy-boned, slow-maturing, rangy type of beef bull will produce cattle as desirable to feed and raise on the range as will the smaller, earlier-maturing, more compact type of bull.
2. To study the cumulative effects of continued breeding of the large and small type beef bulls on heifers and cows resulting from this breeding.
3. To study the effects of liberal and limited amounts of roughage fed during the winter period and subsequent gains on summer range on the growth and development of the progeny from the two types of breeding.

4. To obtain a record-of-performance of large type and small type heifers from grade Hereford cows and purebred Hereford bulls wintering individually on alfalfa hay.

A. H. 80—Improvement of Mutton Type and Wool Characteristics of Rambouillet Sheep through Selection and Breeding:

1. Breeding to improve the body conformation of the Rambouillet to more nearly approach the mutton type and thus help increase the range operator's income from the sale of lambs.
2. To retain or improve the quality of the wool especially with respect to fineness, density, length of staple, and shrinkage.

Out of this project the Animal Husbandry Department is endeavoring to develop a range sheep that will more nearly meet present day requirements of both mutton and wool production.

A. H. 81—Production of Market Lambs by Crossbreeding:

1. To test the merits of Columbia, Corriedale, Hampshire, Romney, and Suffolk rams when crossed with grade Rambouillet ewes for the production of milk-fat lambs when sold directly from forest range at weaning time.
2. To determine the efficiency of lambs from the different crosses in the feed lot.

A. H. 82.—Criss-Crossing or Alternate Backcrossing as a Method of Producing Range Ewes:

This project involves crossing Columbia and Corriedale rams on Rambouillet ewes and subsequent progenies to be alternately backcrossed as a means of

1. Producing suitable lambs for market.
2. Improving the shearing quality by obtaining a fleece with longer staple and lower shrinkage.
3. Retaining the range qualities of Rambouillet ewes.

A. H. 83—Digestibility and Chemical Composition of Montana Range Grasses at Different Stages of Maturity:

1. To compare grasses native to Montana ranges on the basis of digestibility.
2. To determine changes in the digestibility of range grasses at various stages of maturity.
3. To determine chemical composition of these grasses and the carbohydrate content of their roots at various stages of maturity.

DEPARTMENT OF BOTANY AND BACTERIOLOGY

By
H. E. Morris

Functions of the Department

The investigation of plant diseases and the development of effective and practical methods of reducing losses resulting from fungi, bacteria, viruses, and the so-called "physiological" diseases is a major function. In addition, a large amount of public service is rendered in response to requests for identification of and information concerning weeds, the native flowering plants, ornamental and house plants, plants poisonous to livestock and humans, grasses, and fungi.

Another important responsibility is the maintenance and development of a large Herbarium Through the years, Herbarium specimens have been collected, identified and classified. Herbarium specimens are especially useful in identifying plants collected in connection with soil and land-use surveys. Furthermore, the scientific records of many of the Herbarium specimens are exceedingly valuable in tracing the history of a particular plant, or a plant disease within the State.

Active Projects and Their Objectives

B. & B. 3—Miscellaneous Plant Diseases:

1. To make a preliminary investigation and report on the prevalence and severity of a particular disease not covered by other studies of the department.
2. To determine if conditions warrant intensive investigation.

B. & B. 22—Breeding Beans for Resistance to Mosaic and Bacterial Blight:

1. To select strains of the Great Northern bean which are resistant to the mosaic disease and superior to field-run or ordinary seed in type, uniformity of maturity, and yield.
2. To determine if strains of the Great Northern bean vary in resistance to the bacterial blights, e. g. common bacterial blight and halo blight.

B. & B. 25—Location of Phosphorus Deficient Soil Areas in Montana:

1. To determine by the soil-plaque or biological test the mineral deficiency, especially phosphorus, of various types of soil in Montana.
2. To determine the phosphorus content of soils by the Truog colorimetric method.
3. To determine the pH of soils: pH of 7 is neutral while lower

pH values indicate acidity and high values indicate alkalinity.

B. & B. 27—Chlorosis of Strawberry Plants:

Chlorosis is largely responsible for the high unit cost of producing Progressive Everbearing strawberries in Montana, and unless eliminated or materially reduced there will be no market for this variety in this State.

1. To determine the cause of yellowing of the Progressive Everbearing strawberry.
2. To select strains of this variety which are resistant to yellowing.

B. & B. 29—Investigation of Unknown Factors Inhibiting the Fertility of Montana Soils:

1. To determine the factors which affect the fertility of soils in certain areas in Montana.
2. To devise methods or procedures for restoring and maintaining the fertility of such infertile soil areas.

B. & B. 30—Rhizoctonia and Rhizoctonia-like Diseases Affecting the Production of Sugar Beets, Beans and Potatoes:

1. To determine the cause and control of seedling diseases of the sugar beet.
2. To determine the cause and control of diseases which attack sugar beets between thining and harvest, e. g. phosphate deficiency, fusarium, wilt, and others.
3. To determine the effect of previous crops on prevalence of disease on sugar beets.
4. To investigate the effect of crop rotations of various duration, with and without manure, on sugar beet diseases.
5. To correlate, if possible, the effects of rotations including alfalfa, sugar beets, beans, and potatoes on the resulting diseases of these crops.
6. To determine if treatment of sugar beet seed is beneficial and profitable.

DEPARTMENT OF CHEMISTRY AND METEOROLOGY

By

Edmund Burke

Functions of the Department

Chemistry is one of the basic sciences underlying the production of all types or kinds of agricultural products. Regardless of the product, whether it be fruit, forage and grain crops, livestock, milk, poultry, potatoes, or vegetables, producers are employing the materials and forces of nature to obtain the largest possible production of organic foodstuffs. The producers of agricultural products make extensive use of chemical knowledge,

though perhaps in many instances quite unconsciously. Numerous problems which producers encounter can be solved only by exacting and detailed research and analysis by the chemist. Thus, it is the function of the Chemistry Department to employ the science of chemistry either directly or in cooperation with other research departments of the Agricultural Experiment Station in conducting fundamental research into plant and animal problems and to render service to citizens of the State through more or less standard and routine chemical tests.

Active Projects and Their Objectives

Chem. 7—*Meteorology*:
A meteorological record which requires daily records of temperature, humidity, precipitation, wind velocity, hours of sunshine and the rate of evaporation from a water surface. This record, when combined with similar records from a network of meteorological stations at several points within the State, is of value to farmers and ranchers, and also to research workers in other departments of the Agricultural Experiment Station.

Chem. 10—*Miscellaneous Tests and Analyses*:
Simple chemical tests and detailed analyses to assist farmers and ranchers and other citizens of the State when chemical knowledge is required. During the present year, this included 103 samples of soil tested for free carbonates, available phosphorus, pH values, amount of nitrogen, etc. Also were tested several samples of forage, beet tops, etc. for presence of arsenicals

Chem. 19—*Soil Survey Studies*:
During the progress of the soil surveys conducted by the Agronomy Department, the various soil types are sampled systematically at known locations. These soil samples are analyzed by the Chemistry Department to determine total nitrogen, phosphorus, and calcium. Occasionally, samples are designated in the field for analysis to determine the alkali salts.

Chem. 24—*Effect of Phosphate Fertilizers on Yield and Phosphorus Content of Forage Crops*:

1. To determine the effect of phosphate fertilizers on the yield of grain and forage crops.
2. To determine the effect of phosphate fertilizers on the compositon of the crop, including phosphorus content.

Chem. 27—*Biochemical Studies of Factors Affecting the Quality of Wheat and Flour for Milling and Baking*:

1. To determine the effect of phosphate fertilizers upon the

biochemical properties of wheat and flour.
2. Determination of the biochemical properties of flour milled from frozen and immature wheat.
3. Development and properties of the wheat kernel following the stripping of leaves from the plant by grasshoppers.

Chem. 33—*Location of Phosphorus Deficient Soil Areas in Montana*: Investigations designed to assist in locating and determining the extent of phosphorus deficient soils in Montana.

Chem. 35—*Investigation of Unknown Factors Inhibiting the Fertility of Montana Soils*:
1. To determine the factors which affect the fertility of soils in certain areas of Montana.
2. To devise methods or procedures for restoring and maintaining the productiveness of such infertile soils.

Chem. 37—*Miscellaneous Analyses and Observations*: Departments of the Agricultural Experiment Station which deal directly with plant and animal life frequently encounter problems requiring the assistance of the chemist. In such cases, cooperation of the Chemistry Department provides chemical knowledge and assists with the interpretation of results obtained in working out corrective or remedial measures. The Chemistry Department has been particularly helpful in solving some of the problems relating to Agronomy, Animal Husbandry, Botany, Dairy Industry, Entomology, Horticulture, and Veterinary Science.

DEPARTMENT OF DAIRY INDUSTRY

By
J. A. Nelson

Functions of the Department

Research in the Dairy Industry Department is designed to increase the efficiency of dairy production by increasing the production per cow unit economically and to improve the quality of the milk so that higher quality dairy products will result. Efforts are also being made through economies in manufacture and improvements in quality, to popularize the use of dairy products.

Active Projects and Their Objectives

Dy. I. 1—*The Flavor of Market Milk as Modified or Intensified by Pasteurization*:
1. To determine if ordinary flavors of high-grade raw milk, usually defined as feed, smothered, bitter, salty, oxidized, etc., will be diminished or changed in any way by pasteurization.
2. To determine if other flavors which may be due to pasteuri-

zation, such as smothered, cooked, oxidized, etc., may be more or less objectionable than the flavors commonly found in high-grade raw milk

Dy I. 2—*Development of a High Quality and Uniform Cultured Buttermilk for the Commercial Market*:
Designed to develop a method of making cultured buttermilk with a pleasing flavor, creamy body, of good keeping quality, and containing dispersed butter granules similar to the "old type" product taken from the churn.

Dy. I. 3—*Feed Flavors in Milk*:
1. To improve the quality of dairy products by ascertaining what Montana feeds and weeds have a detrimental effect upon the flavor of milk and cream.
2. To study the effect of time and rate of feeding upon the intensity of feedy and weedy flavors in milk.
3. To study any other abnormal flavors in milk.

Dy. I. 4—*Raising Dairy Calves and Orphan Lambs on Dry Meal Containing Powdered Skim Milk*:
To find an inexpensive and practical method of raising dairy calves and orphan or "bum" lambs.

Dy. I. 5—*Feeding the Dairy Cow*:
1. To ascertain the relative feeding value of dried molasses beet pulp and ground oats as a feed for milk production when fed with barley, wheat bran, cottonseed meal, and alfalfa hay.
2. To ascertain the amount of dried molasses beet pulp that may be used without materially affecting the palatability and feeding value of the dairy ration.

Dy. I. 6—*Methods of Feeding and Raising Dairy Calves*:
To compare the feeding value of dried molasses beet pulp and ground oats as a feed for growing dairy heifers when fed with alfalfa hay.

DEPARTMENT OF ENTOMOLOGY

By

H. B. Mills

Functions of the Department

Since injurious insects are frequently the cause of serious financial loss, it is the function of the Entomology Department to investigate outbreaks of insects in the State and to conduct research to discover (1) characteristics of the life history of the pest; (2) new methods of control; (3) refinements in old methods of control to increase efficiency and/or reduce the cost; and (4)

to determine the value of control methods advocated for other areas when applied to Montana conditions. All this requires much collateral work in the fields of insect taxonomy, physiology, and ecology. Insecticidal work requires the application of chemical knowledge and chemical methods.

Active Projects and Their Objectives

Ent. 3—Insect Survey of Montana:

1. Investigation of new insect outbreaks which are not covered by other formal projects.
2. Building up a reference collection of the insects of Montana.
3. Developing the Insect Pest Survey file, including geographical and seasonal distribution of Montana insects.
4. Development of a correspondence file, listing inquiries answered according to the pests mentioned.

Ent. 20—Insects of Abandoned Land:

1. To determine insect populations in relation to plant succession on abandoned lands, to determine at which stage, if any, such abandonments are particularly favorable to the development of injurious insects.
2. To compare insect fauna of such land with nearby cultivated land and unplowed range, to see what striking ecological differences may be found which may explain the dangerous character of this land as an insect breeding ground.
3. To observe migrations of injurious insects from abandoned land to nearby cultivated fields, and accumulate data showing how extensive such migrations may be.
4. To determine the feasibility of applying measures for the reduction of dangerous insect populations in abandoned land, and at what successional stages such measures will be most effective.

Ent. 21—Toxicity of Insecticides:

1. The toxic value of specific insecticides toward insects.
2. The toxic disadvantages toward plants.
3. The physiological action of insecticides.
4. The physical properties of insecticides in relation to their distribution and effectiveness.

Ent. 22—Insect Relation to Plant Virus Diseases with Reference to Bean Mosaic:

1. To determine what insects may be identified with the dissemination and transmission of bean mosaic in the field.
2. To study the life histories, habits, and ecological relationships of those species involved, with special reference to

their possible dissemination of the mosaic virus among wild hosts, and any role which they may play in connection with virus diseases of other crop plants.

Ent. 28—The Life History of the Sugar Beet Webworm:

1. To study very thoroughly the entire life cycle of this insect.
2. To determine the per cent of the first and second generation larvae which go into hibernation and the per cent which emerge as moths the same season.
3. To determine the conditions under which the highest percentage of larvae of the first brood emerge as moths and the conditions which tend to make them hold over until the following year.
4. To determine the "optimum" conditions for larval survival.
5. To determine why outbreaks of great intensity decline so suddenly.
6. To find all possible relationships which can be used in forecasting outbreaks of this insect.
7. To collect data as to food preference.

Ent. 29—Physiology of the Diapause in the Codling Moth with Its Possible Relationship to Control:

1. To study comprehensively the diapause phenomenon in the codling moth.
2. To determine what chemicals, if any, can effectively break the diapause and disrupt the natural cycle of the insect.
3. To develop field methods for application of such means of control as may be indicated.

DEPARTMENT OF HOME ECONOMICS

By

Jessie E. Richardson

Functions of the Department

To study the problems of the rural homes of Montana and to present the results of these investigations to the homemakers in such a way that they may be used as aids in daily living, is the function of the Department of Home Economics. These home problems include (1) the selection, preservation, preparation, and care of foods so that they will be appetizing and nutritious for the family; (2) the selection, construction, and care of textile fabrics so that they will be suitable for clothing or household articles and will possess good wearing qualities; (3) the selection, use and care of household furnishings and equipment so that their utility will compensate their cost; (4) the economic management of money, time and energy for home activities in relation to available re-

sources; and (5) a better understanding of the social relationships that exist among the members of the family.

Active Projects and Their Objectives

H. Ec. 9—Miscellaneous Tests--In 1938, "The Ascorbic Acid Metabolism of College Students":

1. To determine the ascorbic acid (vitamin C) nutrition of freshman college women on their customary diets by measuring their daily ascorbic acid excretion.
2. To determine the reaction of the same subjects to a single massive dose of ascorbic acid as shown by their urinary response.
3. To attempt to establish the daily ascorbic acid (vitamin C) requirements of freshman college women.

H. Ec. 11—Canned and Salted Green String Beans:

1. To compare the palatability and keeping quality of green string beans, when canned, salted or fermented by approved methods.
2. To find whether the canning process causes losses in the vitamin A, B_1, and C content of string beans, by testing them immediately after canning.
3. To find whether the storage of canned, salted and fermented string beans results in progressive vitamin C losses by chemically testing the beans at monthly intervals.
4. To find whether storage causes losses in the vitamin A and B_1 contents of canned, salted and fermented string beans by testing at the end of a six months storage period.
5. To estimate the nutritive value of canned, salted and fermented string beans that have been stored for six months.

H. Ec. 14—Studies of White Wheat Flours:

1. To develop a basic cake formula, satisfactory for the altitude and climatic conditions in Bozeman, using a standard commercial cake or white wheat flour.
2. To test flour made from several varieties of white wheat raised experimentally by the Agronomy Department and accurately milled and bleached in the Montana Grain Inspection Laboratory, by substituting each flour in the basic cake formula and taking comparative measurements.
3. To develop a basic formula for plain rolled cookies, satisfactory for the altitude and climatic conditions in Bozeman, using a standard commercial white wheat flour.
4. To test the experimental white wheat flours, by substituting each flour in the basic cooky formula and taking comparative measurements.
5. To be able to recommend to the Agronomy Department the

preferred variety of white wheat as judged by the satisfaction it gives to the user.

H. Ec. 16—Soaps and Detergents:

1. To compare the cleansing abilities of some of the new detergents on the market with that of soaps, when used on soiled cotton, silk, rayon, linen, and wool.
2. To compare the effect of these detergents and soaps on the appearance, strength, and wearing quality of the various textile fabrics.
3. To compare the use of these detergents and soaps in soft and hard waters.
4. To compare the relative cost of using these new detergents with that of soaps for household purposes.
5. To compare the relative satisfaction derived from using these detergents, and soaps, when judged on a scientific and economic basis.

H. Ec. 17—Oxidation of Ascorbic Acid (vitamin C):

1. To find whether the oxidation of ascorbic acid or vitamin C (a detrimental chemical process that occurs upon the exposure of many food materials) may be prevented by combining the material with certain chemicals, that are generally used in food preparations.
2. To find what influence fruit acids, such as acetic, citric, tartaric and malic acids may have upon the oxidation of ascorbic acid.
3. To find what influence fruit sugars, such as glucose, fructose and sucrose may have upon the oxidation of ascorbic acid.
4. To find what influence pectin, obtained from apples or citrous fruits, may have upon the oxidation of ascorbic acid.
5. To find whether varying combinations of fruit acids, fruit sugars, and pectin may prevent or hasten the oxidation of ascorbic acid.

DEPARTMENT OF HORTICULTURE

By

F. M. Harrington

Functions of the Department

Horticultural crops in Montana are grown for two purposes: (1) to contribute to the home living, and (2) as a source of direct cash revenue.

Production of fruits and vegetables is an important undertaking on many Montana farms and ranches and in Montana towns and cities. Varieties and methods which will give the widest

assortment add value to the home fruit and vegetable garden. It is, therefore, an objective and a function of the Department of Horticulture to study varieties and to work out methods which will result in production of a wider range of products which will be available throughout longer periods of the year. This involves, too, studies to make production for home use possible under distinctly unfavorable conditions.

Apples, cherries, strawberries, raspberries, potatoes and vegetables are commercial crops in the State. The life of the tree, and its functioning, are subject to weather, water, fertilizer, and various environmental factors. Potatoes, vegetables and small fruits are likewise influenced. What things influence tree and small fruit hardiness? How may yields be increased? How can quality be improved? Montana can not look to other experimental stations for all this information. Our weather and soil conditions are not the same. Every grower can not carry on extensive experimental work. Therefore, it is the purpose of the Department of Horticulture to study problems encountered by fruit and vegetable growers, test out the results, and give to the growers the benefits of these findings.

Active Projects and Their Objectives

Hort. 4—Variety and Cultural Tests with Vegetables:
(New varieties are continually being introduced by individual growers, by seed houses, by the United States Department of Agriculture, and by various State Agricultural Experiment Stations.)

1. To test these new introductions and determine their adaptability to Montana conditions.
2. To study field practices which may contribute greater values, such as earliness, greater yield, better quality and maturity.

Hort. 5—Ornamental Trees and Shrubs:
The discovery of new varieties of ornamental shrubs and plants which may be added to the list of species adapted to Montana requires tests for hardiness and general suitability.

Hort. 11—Miscellaneous Tests:
Miscellaneous observation and preliminary investigations are included. Possibilities of plant breeding, as applied to potatoes and chrysanthemums are now being explored to obtain information on pollen production, seed setting and seed viability, since great variations occur between regions.

Hort. 34—The Relation of Growth to Fruiting and Quality of the McIntosh Apple:

1. To determine the type of growth suited to proper func-

tioning of the tree.
2. To determine the influence of factors, principally commercial fertilizers, upon the tree and the character of crop produced.

Hort. 38—Study of Transplant Growing Methods:
1. Are transplants equal in value?
2. Will nutrients, temperatures, soils, and other factors change transplant values?
3. Will transplant treatments influence the final crop and have any bearing upon yields, quality, diseases, etc.?

Hort. 39—Factors Influencing Maturity of Potatoes:
Investigation of potato growing, with special reference to seed, fertilizers, rotations, irrigation, etc., to determine the combination of practices which will give maturity of tubers by the time harvesting must take place in Montana, without reducing either yield or grade.

Hort. 40—Factors Which Modify Type, Shape, and Grade of Potatoes:
Since poor type and low grades contribute to high unit costs of growing and handling potatoes, this project has as its primary objective the improvement of production methods which will improve the grade.

Hort. 44—Role of Phosphorus in Potato Production:
Since phosphorus is deficient in many Montana soils, this study was undertaken to determine
1. The place of phosphorus in potato production in respect to its effect on the crop.
2. Responses under various conditions and methods of application.

Hort. 45—Physiological Forms of Witches Broom Disease (Haywire) of Potatoes:
In various parts of the State, potato troubles occur which resemble virus diseases in some respects, but appear in other ways to be caused by something other than a virus. The influences of nutrition and environment on some of these diseases are being investigated.

Hort. 49—Fertilizer Infuences on Sweet Cherry Trees:
An investigation to determine the effects of fertilizers and certain cultural practices upon hardiness, growth, early bearing, productivity, and longevity of the sweet cherry tree. This work is located on the east shore of Flathead Lake in an orchard controlled by the Department of Horticulture.

DEPARTMENT OF IRRIGATION AND DRAINAGE

By

O. W. Monson

Functions of the Department

Montana ranks fourth among the states in acreage under irrigation, with 1,594,912 acres being irrigated. While only 1.7 per cent of Montana's total land area is classed as "irrigated", irrigation farming is practiced to a greater or lesser extent on 27 per cent of all farms (includes ranches) in the State. The valuation of land and buildings on these irrigated farms and ranches represents 36 per cent of the total valuation of land and buildings on all farms and ranches in Montana. It is significant also that the irrigated farms and ranches provided homes for 33 per cent of the people who lived on all farms and ranches in Montana in 1930.

Irrigation occupies a position of commanding importance in Montana by providing stability of production and income in agriculture, as well as in other lines of business.

With one-third of the farm and ranch population of Montana interested directly in types of agricultural production dependent largely upon irrigation, it is to be expected that the Department of Irrigation and Drainage should be confronted with numerous problems. However, a small department, with limited funds, undertakes research on only a few of the more pressing irrigation problems. Progress is being made with investigations on low-cost water-lifting equipment, methods of irrigation, inventory of Montana's water resources available for irrigation, and improvement of range vegetation through water conservation.

On July 1, a beginning was made with investigations of problems in the field of Rural Electrification. This field, largely unexplored in Montana, presents many problems of importance to farm and ranch people.

Active Projects and Their Objectives

Irr. 3—Water Power Utilization on the Farm:

1. To study present use of water power on Montana farms and ranches with both home-made and commercial equipment.
2. To design, construct and test home-made water wheels.
3. To design, construct and test home-made water-lifting devices capable of supplying water for irrigation efficiently and economically.
4. To test commercial water-wheels, turbines and pumps for farm installations.

Irr. 4—Methods of Irrigating Peas to Overcome Pathological Effects:

1. To determine what causes "scalding" of irrigated peas.
2. To study the effect of irrigation on the development of root rot and fusarium.
3. To determine what varieties are most susceptible to damage.

Irr. 5—Investigation of the Water Supply from Montana's Rivers and Streams with Special Attention to Its Use for Irrigation:

1. To determine annual runoff from various watersheds.
2. To determine seasonal distribution of runoff.
3. To determine possibilities of forecasting runoff.
4. To determine correlation between precipitation and runoff.

Irr. 6—Effect of Irrigation on the Yield and Quality of Vegetables:

This project is designed to determine the effect or influence of varying amounts of water and frequency of irrigation and the method of applying water upon—

1. The yield and grade of vegetables.
2. The root system development and location in the soil.
3. The character of plant growth.
4. The quality, palatability, and nutritive value of the vegetable grown.

Irr. 7—Miscellaneous Observations:

This project provides for observations on irrigation and drainage problems not covered by other formal projects. Data have been collected on the duty of water and precipitation by months on all Federal Reclamation projects up to 1936. By comparison of these data, it is observed that a slight deficiency in precipitation is generally accompanied by liberal irrigation, while a small excess of rainfall is reflected by a marked reduction in irrigation water applied, thus confirming the warning often given that there is a general and rather wasteful tendency to over-irrigate.

Irr. 8—Range Improvement by Water Conservation:

Rainfall records and stream gagings in Montana show that there is a tremendous loss of water from runoff in all parts of the State. Even in those parts of the State where the yearly rainfall is insufficient to produce crops, there is lost by runoff from 25 to 75 acre feet of water per square mile of watershed annually. The objectives are—

1. To determine economical methods of water spreading adapted to conservation of flood waters from range land.
2. To determine the effect of water conservation on the composition, volume and density of native range vegetation.

Irr. 9—Rural Electrification Investigation:

1. To determine operating characteristics of equipment when such data are not available from other reliable sources.
2. To determine suitability of various types of electrical equipment for use on Montana farms and ranches
3. To develop home-made appliances and devices for use on Montana farms and ranches when they can be made in compliance with national and local safety regulations.

DEPARTMENT OF LIBRARY AND PUBLICATIONS

By

F. B. Linfield

Functions of the Department

The maintenance of a reference library for the use of the research staff of the Agricultural Experiment Station and the preparation of departmental manuscripts for publication are the major functions of the Department of Library and Publications.

A complete and up-to-date reference library is an important and very necessary part of the equipment of an effective research staff. Considerable time is required each year in assembling, recording, and making available the reference publications from Federal, state, and private agencies in the United States and from foreign countries.

The results of investigations are assembled and analyzed from time to time by the various research departments, and with suitable interpretations, the information is prepared in manuscript form and submitted for publication. Critical editorial attention by research workers in other departments helps to insure the correctness of the interpretations and conclusions presented before the manuscript goes to the printer.

Publications Issued

The results of research are published as bulletins and circulars for general distribution and as mimeographed circulars and special journal articles for a more limited mailing. A printed list of publications available for general distribution may be obtained upon request.[1]

During the period December 1937 to November 1938, the publications of the Montana Agricultural Experiment Station included 14 bulletins, 2 circulars, one annual report, 7 mimeograph cir-

[1]Montana residents may obtain the publications of this station without cost by writing to the Library-Publications Department, Montana Agricultural Experiment Station, Bozeman, Montana, and indicating the number and title of the publication desired, or by applying to the Agricultural Extension Agent of your county. The Station will gladly place your name on the mailing list to receive publications of special interest as issued.

culars, and 13 journal articles, totalling 661 pages. This list of publications follows:

Bulletins:

No. 351. Does Grasshopper and Cricket Control Work Involve Hazards to Livestock? F. T. Donaldson and H. Welch. First Edition—Jan. 1938, 2500 copies, 7 pages. Second Edition—June 1938. 5000 copies, 7 pages.

No. 352. Analyses of Commercial Fertilizers. J. T. Sparling and Edmund Burke. Jan. 1938, 2500 copies, 8 pages.

No. 353. Irrigation Development in Montana. Part I. Water Supply. O. W. Monson, Clyde McKee and P. L. Slagsvold. Jan. 1938, 6000 copies, 56 pages.

No. 354. Some Economic and Social Aspects of Irrigation in Montana. P. L. Slagsvold and J. D. Matthews. Jan. 1938, 5000 copies. 24 pages.

No. 355. Soils of Fergus County. L. F. Gieseker. Feb. 1938, 2000 copies, 82 pages.

No. 356. Phosphate Investigations on Irrigated Crops. J. R. Green. April 1938, 5000 copies, 31 pages.

No. 357. Agriculture on the Flathead Project. P. L. Slagsvold and J. D. Matthews. April 1938, 2500 copies, 23 pages.

No. 358. Montana Cattle Shipments. P. S. Eckert and P. L. Slagsvold. May 1938, 4000 copies, 44 pages.

No. 359. Fattening Range Calves in the Feedlot. W. F. Dickson. June 1938, 4000 copies, 22 pages.

No. 360. Montana Farm Bankruptcies. R. R. Renne. June 1938, 4000 copies, 53 pages.

No. 361. Dysentery of New-Born Lambs. (Technical) H. Marsh and E A. Tunnicliff. July 1938, 2500 copies, 44 pages.

No. 362. Fruit Cracking of Tomatoes as Influenced by Applying Potassium Permanganate to Soils in Which the Transplants Are Grown. V. E. Iverson. August 1938, 4000 copies, 16 pages.

No. 363. Soils of Petroleum County. L. F. Gieseker. August 1938, 2000 copies, 48 pages.

No. 364. Analyses of Commercial Fertilizers. Edmund Burke and J. T. Sparling. October 1938, 3500 copies, 16 pages.

Circulars:

No. 152. Bang's Disease. Howard Welch. May 1938, 5000 copies, 12 pages.

No. 153. Dysentery of New-Born Lambs. Montana Veterinary Research Laboratory. July 1938, 5000 copies, 8 pages.

Annual Report:

44th. Adjusting Montana's Agriculture. Forty-Fourth Annual Report. November 1938, 6500 copies, 60 pages.

**Mimeograph Circulars*:

No. 4. Vegetable Transplant Experiments in Montana. V. E. Iverson. December 1937, 300 copies, 7 pages.

No. 5. Western Wheatgrass, A Valuable Native Forage Crop. L. P. Reitz. December 1937, 400 copies, 5 pages.

No. 6. A Method for the Valuation of Livestock Ranch Properties and Grazing Lands. M. H. Saunderson. March 1938, 600 copies, 20 pages.

*Mimeograph circulars are issued in limited editions and are not available for general distribution.

No. 7. A Summary of Producers Reports on the Sale of Livestock by Auction in Montana. P. S. Eckert. April 1938, 500 copies, 9 pages.

No. 8. A Method of Calculating the Probable Financial Results of Livestock Fattening Operations. M. H. Saunderson and Arthur Roth, Jr. April 1938, 350 copies, 14 pages.

No. 9. Key to the Grasshoppers of Montana. H. B. Mills and J. Pepper. June 1938, 250 copies, 28 pages.

No. 10. Supplementary Tables for Bulletin 367, "Farm adjustments in Montana," Major Area VII. (Part II of "Types of Farming.") Montana Agricultural Experiment Station in cooperation with Bureau of Agricultural Economics, U.S.D.A. 250 copies, 10 pages.

Journal Articles:

No. 92. A study of B. Necrophorus in Soil Cultures. E. A. Tunnicliff. Journal of Infectious Diseases. Jan.-Feb. 1938. Vol. 62, pp 58-65.

No. 96. Healthy Cattle as Carriers of Coccidia. H. Marsh. Journal of American Veterinary Medical Association. Feb. 1938, Vol. 92 (New Series Vol. 45), pp 184-194.

No. 98. Study of the Mineral Nutrition of Wheat as Influenced by Fertilizer Combinations. F. T. Donaldson. Plant Physiology. Oct. 1938. Vol. 13, No. 4, pp 737-766.

No. 100. Pneumonia in Rocky Mountain Bighorn Sheep. H. Marsh. Journal of Mammology. May 1938. Vol. 19, No .2, pp 214-219.

No. 101. Two New Materials in Plant Nutrition. V. E. Iverson. American Society of Horticulture Science. Bulletin, Vol. 35, 1937 (published April 1938) pp 763-767.

No. 102. Hard Seeds in Legumes: Correlation B. Between Laboratory and Field Germination. W. O. Whitcomb. Proceedings of Association of Official Seed Analysts of North America, 29th Meeting. 8 pages.

No. 103. Hard Seeds in Legumes: Summary of Labeling Requirements of State Laws and Methods of Reporting by Laboratories. W. O. Whitcomb. Proceedings of the Association of Official Seed Analysts of North America. 1937. pp 34-40.

No. 105. The Effect of Certain Climatic Factors on the Distribution of the Sugar Beet Webworm (Toxostege Sticticolis L.) in North America. J. H. Pepper. Ecology. October 1938, Vol. 19, No. 4, 6 pages.

No. 106. An Improved Medium for the Storage of Actinomycoes Necrophorus Cultures. E. A. Tunnicliff. Journal of Infectious Diseases. July-August 1938. Vol. 63, pp 113-116.

No. 113. Need for Research in the Field of Hydrology. O. W. Monson. Northwest Science. May 1938. Vol. XII, No. 2, pp 26-31.

No. 114. Land Credit Practices and Successful Farm Operation. R. R. Renne. Journal of Land and Public Utility Economics. November 1938, pp 442-451.

No. 115. Laboratory Germination Studies with Agropyron Smithii—Preliminary Result. W. D. Hay. Proceedings of the Association of Official Seed Analysts of North America, 1938. pp. 67-70.

No. 116. Seed Value of De-hulled Oats—Preliminary. W. O. Whitcomb. Proceedings of the Association of Official Seed Analysts of North America, 1938. Pp. 255-258 inc.

MONTANA GRAIN INSPECTION LABORATORY

By
W. O. Whitcomb

Functions of the Department

The Montana Grain Inspection Laboratory is primarily a service institution with research as a secondary objective. The services rendered deal with grain and seeds, and the research is, for the most part, intended to aid in rendering more adequate service.

Five lines or kinds of direct service are rendered by the Laboratory, namely: (1) grain inspection and grading; (2) protein testing; (3) milling and baking flour tests; (4) seed testing; and (5) seed inspection. Each of these services is of importance, either directly or indirectly, to those engaged in the buying and selling of grains and seeds, and to the milling industry in the State.

Services Rendered

Grain Inspection and Grading: Because of adequate equipment and and properly trained staff members, the Laboratory is authorized to inspect and grade grain according to Federal standards. Thus, it is possible for those who buy and sell grain to submit representative samples of the grain in question for scientific analysis. The detailed and unbiased information obtained provides a more intelligent basis for the merchandising of grain.

Protein Testing: The protein test of wheat is considered to be the best and most reliable quick test of normal, undamaged wheat to show its bread-making properties. Flour mills are making very practical use of the protein test in buying and blending wheats for milling. Farmers often profit by having their wheat tested for protein content before offering it for sale. Many Montana flour mills depend upon this laboratory to test their blends, and also to test their flour for delivery on contracts. The Experiment Station uses the protein test as an important criterion of value in selecting wheats in a breeding program.

Milling and Baking Flour Tests: The Laboratory provides facilities whereby new wheats being developed either by farmers or by the Experiment Station may be submitted to exacting milling and baking tests to determine whether they possess any undesirable qualities. Also, samples of flour may be submitted by individuals and by millers for baking and other special tests.

Seed Testing: The Laboratory provides up-to-date facilities for making purity and germination tests of farm and garden seeds for citizens of the State. This service provides reliable information as to the purity of the seed in question and whether or not any noxious weeds are present; also, germination tests provide

definite assurance of the capacity of the seed to germinate when planted under favorable conditions in the field.

Seed Inspection: The Montana Seed Law authorizes the Montana Grain Inspection Laboratory to inspect samples of seed offered or exposed for sale within the State, and to make purity and germination tests to determine compliance with the labeling requirements of the Law. This is a valuable service because it informs the buyer as to the true name and origin of the seed, its germination, and whether or not noxious weed seeds are present. This service makes good seed available to Montana seed users and prevents the State from becoming the "dumping ground" for poor seed from other states.

Research Projects and Their Objectives

Research is conducted in methods of making milling and baking tests and the proper evaluation of the desirable properties in milling wheats. Special studies are also made of the methods of testing seeds of various crops for germination and the interpretation of these results in terms of plant producing capacity when the seed is planted in the field. In both of these lines of investigation, close contacts are maintained with similar laboratories in other states through national organizations or associations.

Grain Lab. 1—Miscellaneous Services:

1. To keep record of number of samples of grain, seed, flour, etc., tested in the various lines of service work.
2. Participation of staff members in the work of National organizations in order to keep the services of the Laboratory up-to-date.

Grain Lab. 3—Stage of Maturity of Seeds in Relation to Germination:

1. To determine the seed value of immature seeds of various kinds and how the laboratory test interprets this value in terms of crop producing value in the field.
2. To determine other characteristics of immature seeds which may be associated with their germination and seed value, including moisture content at time of harvest, average weight per seed, and specific gravity or density of seed.
3. To determine the influence of freezing at various stages of maturity on germinative capacity of seeds.
4. To determine the influence of drouth and rust on the seed value of grains.
5. To determine seed value of light weight wheat. A special study is being made of this.

Grain Lab. 4—Methods of Making Germination Tests:

1. Use of different media for testing germination of the various seeds.

2. Special tests for determining value of weak seeds.
3. Influence of light and temperature on the germination of different kinds of seeds.
4. Referee testing in which germination results obtained in the Montana Laboratory are compared with those from laboratories in other states.

Grain Lab. 6—Values of Hard Seeds in Legumes and Methods of Treatment:

1. Vitality of seeds which remain hard at the end of the laboratory test.
2. How to interpret the seed value of hard seeds in terms of their plant producing properties.
3. Under what conditions is the scarifying of legume seeds, which contains hard seeds, beneficial.

Grain Lab. 8—Milling and Baking Tests of Montana Wheats:

1. Determine which of the new wheats being introduced into Montana are acceptable as milling wheats.
2. Blending properties of new wheats with the standard varieties to make an acceptable commercial flour.
3. Blending properties of wheats of high and low protein contents for the making of flour.
4. Flour making properties of wheats damaged by drouth and rust.

Grain Lab. 14—Qualities and Uses of White Wheats:

1. To study the quality of white wheats produced under irrigation in Montana and determine how they may be used to advantage in the milling industry.
2. To determine the value of this white wheat flour for cakes and cookies.
3. To study blends of these white wheats with hard red wheats for making bread flour.

DEPARTMENT OF VETERINARY RESEARCH

By

H. Marsh

Functions of the Department

The function of the Veterinary Research Laboratory is to investigate the diseases of cattle, sheep, and horses which may be of importance to the livestock industry of Montana. It is the policy of this laboratory to confine its efforts to disease problems, or phases of disease problems, which are more or less peculiar to Montana conditions, and which are not being attacked adequately by other experiment stations. The objective of this work is to obtain information which will enable Montana stockmen to eliminate some

of the economic losses which occur as the result of disease. This information is gained through field investigations and observations, and through laboratory study and animal experimentation at the Experiment Station. The Montana Livestock Sanitary Board cooperates with the Montana Agricultural Experiment Station in the Veterinary Research Laboratory. Special investigations are made at the request of the Livestock Sanitary Board, and the Research Laboratory at Bozeman is kept in contact with conditions in the State through the field force of the Livestock Sanitary Board and the diagnostic laboratory in Helena.

Active Projects and Their Objectives

Vet. 9—Miscellaneous Observations:

To make preliminary investigations of disease problems which are brought to our attention by stockmen and by the Livestock Sanitary Board.

Vet. 12—Coccidiosis in Cattle:

1. To determine what species of coccidia occur in Montana cattle.
2. To determine the conditions under which coccidia produce disease in calves.
3. To develop methods of prevention and treatment.

Vet. 15—Progressive Pneumonia (Lunger Disease) of Sheep:

1. To determine whether there is any evidence of transmissibility of this disease.
2. To analyze the results of chemical and histological work which has been done here to determine whether inhaled dust may be a factor.
3. To compare the incidence of the disease in sheep of the same origin handled under range and farm conditions.

Vet. 32—Intestinal Parasites of Sheep:

1. To determine what species of intestinal worms are of importance in Montana.
2. To determine the most effective methods of treatment.

Vet. 33—Necrobacillosis in Sheep and Cattle:

1. To determine whether the virus of sore-mouth in Montana is identical with the Texas virus.
2. To study the atypical strain of the bacillus of necrosis found as a secondary invader in sore-mouth.

Vet. 35—Methods for Control of Bang's Disease in Range Cattle:

1. To perfect and put into practical use the field blood test which has been developed at this laboratory.

2. To determine whether an annual fall test, with a short breeding season, will control the disease in range cattle.

Vet. 36—Methods of Control of Mastitis in Sheep:

1. To continue efforts to produce immunity.
2. To obtain further information on the source of the infection and means of transmission.
3. To develop methods of management which will minimize the chance of infection.

Vet. 38—A Study of the Virus of Infectious Anemia (Swamp Fever) of Horses, With Particular Application to the Differential Diagnosis of the Disease:

The objective of the present phase of this project is to determine the value of the sedimentation rate of the blood in diagnosis of the disease.

BRANCHES OF THE MONTANA AGRICULTURAL EXPERIMENT STATION

Montana, a state with an immense land area, presents entirely too many variations of climate and soil to expect adequate research from one agricultural experiment station. Farmers and ranchers and other public spirited citizens recognized this fact many years ago, and as a result of the demand from prominent agricultural areas within the State, a group of five branch stations has been established, three owned by the State and two owned by the Federal Government. In the following pages, the superintendents have described the functions of the branch stations and have listed the projects under investigation, with the objectives.

JUDITH BASIN BRANCH STATION*

Moccasin, Montana
By
R. M. Williams

The Judith Basin Branch Station is concerned primarily with the investigation of the more pressing crop and soil problems of

*The Judith Basin Branch Station, established in 1907, is owned by the Montana Agricultural Experiment Station. One hundred and sixty acres of the land was a gift from the late Senator S. S. Hobson of Lewistown, Montana, while the remainder is leased from the State. Memoranda of understanding and cooperative agreements between the Montana Station and the Bureau of Plant Industry, United States Department of Agriculture, provide for cooperative research on some of the problems which are characteristic of central Montana.

the non-irrigated bench lands of central Montana. With an elevation of approximately 4300 feet above sea-level, a frost-free period of 123 days, and a long-time precipitation record of 14.85 inches annually, research is concentrated largely on the problems related to the production of adapted grain and forage crops, including dry-land pastures, shelter belts, and gardens. At present, there are several major groups of investigations.

Dry-land Rotations and Tillage Methods: These investigations seek to determine the effectiveness of each of several different methods of tillage, and the value of crop rotation or crop sequence in the conservation and use of available moisture for the production of adapted crops on the non-irrigated bench lands of central Montana. Specific studies include—

J. B. 1—Dry-land Rotations for Winter Wheat.
J. B. 2—Tillage Methods for Preparing Summer Fallow Land for Winter Wheat.
J. B. 3—Dry-land Rotations and Tillage Methods with Spring Wheat.
J. B. 4—Dry-land Rotations and Tillage Methods with Oats.
J. B. 5—Dry-land Rotations and Tillage Methods with Barley.
J. B. 6—Dry-land Rotations and Tillage Methods with Flax.
J. B. 7—Dry-land Rotations and Tillage Methods with Corn.
J. B. 8—Dry-land Experiments with Potatoes.
J. B. 9—Potatoes in Rotation with Oats.
J. B. 10—Commercial Field Production of Crops for Feed.
J. B. 11—Production of Foundation Seed Stocks of Adapted Varieties of Small Grains.

A long-time and rather complete climatic record is providing a sound basis for the correct interpretation of the agronomic research in terms of approved cultural practices.

Forage Crops: These investigations are concerned chiefly with those crops which show promise as producers of forage, whether used for grazing or as hay. The principal activities include variety tests of both native and introduced species, determination of their cultural requirements, regrassing abandoned crop lands, and possibilities of hay and seed production. Specific studies include—

J. B. 101—Varietal Test of Alfalfa.
J. B. 109—Grass Varieties and Methods of Planting.
J. B. 110—Autumn Plantings of Alfalfa, Grasses, and Sweet Clover.
J. B. 111—Grass Nursery to Study Selected Strains or Varieties of Native and Cultivated Species for Both Pasture and Hay Production.
J. B. 112—Sweet Clover Varieties and Methods of Planting.

J. B. 114—Small Grains, Pea-Grain Mixtures, and Peas for Hay.
J. B. 115—Date of Planting Oats for Hay.
J. B. 125—Corn Varieties.
J. B. 127—Sweet Clover and Grass Mixtures Sown with Wheat and Other Cereals.
J. B. 131—Methods of Securing Stands of Crested Wheatgrass on Abandoned Lands.

An important phase of the forage crop investigations is to determine the reactions of the better grass species when grazed by livestock on a practical pasture basis.

Animal Husbandry: The studies with livestock are limited to beef cattle and at present deal with their feeding and management for meat and milk production. During the summer, an opportunity is afforded for studying the development of yearlings when grazed on pastures of native grass, brome grass, and crested wheatgrass. The winter months are used for limited observations of the value of home-grown roughages for wintering stock.

During the summer pasture experiments, the following observations are made:

1. Comparison of pastures of crested wheatgrass and brome grass with native grass.
2. The change of cover of the various pastures due to grazing.
3. The carrying capacity of the grass in each pasture in terms of production of beef.
4. The production of beef per acre at various periods and throughout the grazing season.
5. The change of composition and feed value of the various grasses.
6. The response of the different grass species to the application of phosphate fertilizer and the chemical change of the feed.
7. The growth of the grasses during the grazing season.

Cereal Crops: A cooperative agreement between the Montana Agricultural Experiment Station and the Division of Cereal Crops and Diseases, Bureau of Plant Industry, U. S. D. A., makes possible research on the production and improvement of cereal crops, including spring and winter wheats, barley, oats, rye, flax, and corn. Other cereal crop investigations include studies on seed bed preparation and dates, rates, depth, and methods of seeding.

Since central Montana will probably continue to produce some wheat on the better farming lands, the central objective of the cereal investigations will aim at the production of a superior variety of winter wheat—one which possesses winter-hardiness

to a high degree, disease resistance, and high yield, combined with high quality for bread making purposes.

Shelter Belts and Windbreaks: This station is also investigating the value of shelter belt or windbreak plantings. Specifically, the studies include—

J. B. 12—Shelter belt Investigations to Determine Adaptability of Species and Methods of Planting and Spacing.
J. B. 13—Coniferous Species—to Determine Species Best Adapted, also Effect of Spacing on Survival and Growth.
J. B. 20—Spacing and Thinning of Evergreen Trees.

Dry-Land Garden: The possibilities of providing a more adequate and economical family diet through the dry-land garden are being explored.

HORTICULTURE BRANCH STATION*

Corvallis, Montana

By

W. E. Pollinger

The principal interest in commercial horticulture in Montana is centered west of the Continental Divide in the Bitterroot and Flathead valleys. The Horticulture Branch Station is located near Corvallis in the Bitterroot Valley (in Ravalli County), and through its location, this Station is in a position to study the problems of tree fruits, small fruits, and vegetables climatically adapted to the intermountain valleys west of the Continental Divide. Further, the Horticulture Branch Station makes possible the investigation of fruit and vegetable problems that cannot be studied at the main station at Bozeman. The investigations at the Station at Corvallis include among others, the adaptability of fruit and vegetable varieties, problems of production, and the winter-hardiness of tree fruits. Investigation of winter-hardiness involves cultural practices including fertilizers, which will bring about earlier maturity and put the tree in better condition for winter without imparing production and quality of fruit.

Practical problems typical of a commercial fruit and vegetable region are being studied, including original research on problems peculiar to Montana and studies to determine the adaptability of recommendations based on research conducted by other experiment stations.

*The Horticulture Branch Station, established in 1907, was made possible as the result of a gift of 20 acres of land by the Bitterroot Valley Irrigation Company to the Montana Agricultural Experiment Station to be used for experiments with fruits and vegetables. Later, the land area of this station was increased to 30 acres through the purchase of 10 acres additional. This station is operated strictly as a State Station, there being no cooperative arrangements with the United States Department of Agriculture.

Active Projects and Their Objectives

H. B. 2—Variety Tests of Commercial Fruits:

1. To test out various tree fruits with the express purpose of finding additional varieties of apples which can be used for commercial production in Montana, in addition to the McIntosh.
2. To locate, if possible, varieties of pears, peaches, prunes, plums, and cherries which are better adapted to commerical production in western Montana.

H. B. 5—Value of Commercial Fertilizers in Orchards:

1. To determine the influences of nitrogen, phosphate, and potash, as well as various minor elements, upon fruit production in western Montana.
2. To work out a commercial fertilizer program, probably tied in with the use of cover crops, which will contribute to healthier, longer-lived trees, better production, and better quality of fruit.
3. To correlate commercial fertilizer practices with other orchard operations.

H. B. 8—Miscellaneous Observations:

A study of miscellaneous problems of concern to both major and minor crops which have not yet been authorized for special study.

H. B. 13—Factors Influencing Potato Production in Western Montana:

1. To improve yields and quality of potatoes through irrigation, the application of fertilizer, and by the use of other cultural practices.
2. To determine the value of improved seed and to determine seed improvement methods.

H. B. 14—Sour Cherry Production Problems in Western Montana:

1. To determine character of trees and root stocks best suited to western Montana conditions.
2. To determine factors which will result in early bearing of cherries.
3. To determine factors which will contribute to longer life and yield of trees.
4. To increase productivity and improve quality of fruit.

H. B. 16—Tests of Small Fruit Varieties:

1. To determine the value of the numerous new varieties of fruits being introduced by nurseries, experiment stations, and the United States Department of Agriculture.

2. To find, particularly with strawberries, varieties which are not subject to the yellows and which have combined the other good merits of the Progressive Strawberry.

H. B. 17—Tests of Ornamentals, Including Trees, Shrubs, and Perennials:

1. To discover new varieties of plants which can be added to the list of adapted ornamentals for western Montana.
2. To study their hardiness in various stages of growth and to determine their suitablility for use in Montana.

H. B. 18—Tests of Vegetable Varieties:

To determine the value of new vegetable varieties which are being continually introduced in the effort to find varieties which will be superior to those now available or which will serve a distinct purpose as supplementing the varieties now in commercial use.

H B. 19—Vegetable Transplants:

Since the method of producing vegetable transplants has had some influence upon results in the field, the objective is to determine to what extent the various methods of growing transplants can influence the crop in respect to time of maturity, length of season, yields, quality, and grade.

H. B. 20—Vegetable Cultural Practices:

1. Since the Montana season is short and early frost is a factor, this project includes a study of cultural practices designed to hasten maturity.
2. Improving yields and quality of vegetables.
3. Determination of fertilizer programs as associated with other practices which are best suited to the western part of the State.

H. B. 21—Study of Factors Which Modify the Type, Shape and Grade of Potatoes:

The sole objective of this project is that of determining how potatoes can be produced through the proper use of fertilizers, irrigation, and other cultural treatments, to improve the type and increase the percentage of tubers of the better grades.

H. B. 22—The Role of Commerical Fertilizers in Potato Production in Western Montana:

1. To determine the influence of adding the various individual fertilizer elements upon yield and quality of the potato crop.

2. To determine the influences of these elements as used in combination.
3. To evolve a fertilizer program suited to western Montana conditions.

H. B. 23—Winter Injury in the Sour Cherry:

Since one of the main problems in cherry growing is that of winter injury, this project provides for an investigation of growing conditions which may result in better maturity and higher resistance to winter injury. It involves studies of root stocks and propagation methods, as well as fertilizers, pruning, shading, and cover crops.

H. B. 24—Cover Crop Problems in Orchards:

Since it has been very clearly demonstrated that orchards cannot be maintained to good advantage in clean cultivation and that under clean cultivation distinct problems of winter injury, diseases, and nutrition are involved, it is the object of this project to:

1. Determine crops best suited to use as cover crops in orchards in western Montana,
2. Determine how these cover crops can best be established and maintained,
3. Study fertilizer and irrigation problems involved when cover crops are maintained.

H. B. 25—Physiological Disorders in Horticultural Crops:

To determine how best to handle and meet such problems as drought spot, little leaf, rosette, and some stages of witchs broom which seem to be due to nutritional deficiencies, temperature factors, or some cause other than a definite disease organism.

H. B. 26—Maturity Studies in Potatoes:

Since in Montana the calendar frequently determines the dates on which the potatoes must be dug rather than the condition of the tubers or the vine, the object of this project is to study ways and means of having potatoes in a better state of maturity at the time of harvesting in order to improve the grade, handling and keeping qualities.

HUNTLEY BRANCH STATION*

Huntley, Montana

By

Dan Hansen

The Huntley Branch Station serves the Yellowstone Valley area and other areas of Montana having similar climatic and soil conditions. The work of the Station includes investigations in the production and utilization of both irrigated and dry-land crops and in dairying and sheep feeding. Facilities are provided for cooperative research by specialists from various departments of the Montana Agricultural Experiment Station, as well as from the United States Department of Agriculture.

In addition to the long-time fundamental research projects in crop and livestock production that have been under way since the Station was started, it is also the function of the Station to conduct experiments that will aid in the solution of problems as they may arise from time to time in the agriculture of the region. This might include such activities as the testing or development of new crop varieties and cultural practices, methods of livestock management and feeding, methods of disease and insect control, etc.

Results of the Station work are made available through timely publications, through contact with visitors to the Station, and by field demonstrations.

Active Projects and Their Objectives

Experiments with Irrigated Crops

1. Crop Rotations:

The work with irrigated crop rotations in 1938 was a continuation of the long-time rotation studies that were started in 1912, and that have been added at various times in more recent years. This project has already yielded information of much fundamental value in the maintenance of a successful irrigated agriculture in the area and will become increasingly valuable as it is continued. The project includes a series of 31 crop rotations of from two to six years in length and in which the seven more important crops of the region are grown in various combinations and sequences, and in addition 15 plats that are cropped continuously to the same crop. This series affords an

*The Huntley Branch Station, established in 1910, is owned by the United States. Memoranda of Understanding and Cooperative Agreements between the Bureau of Dairying and Bureau of Plant Industry of the U. S. D. A., and the Montana Agricultural Experiment Station provide for cooperative research in dairying, dry-land agriculture, and irrigation farming. This cooperation requires the direct participation in research by staff members in the Departments of Agronomy, Animal Husbandry, Botany and Bacteriology, Chemistry, Dairy Industry, Entomology, and Horticulture, of the main station at Bozeman.

opportunity to study the effects of crop rotation, as compared to continuous cropping, and the value of alfalfa, barnyard manure, and commercial fertilizers in crop rotation.

2. *Maximum Crop Producing Capacity of Irrigated Soils*: This project has been under way since 1926 and is designed to determine the maximum crop yielding capacity of soils on the Huntley Station. The experiment involves the growing of seven crops in a combination of two rotations, and through the use of such cultural practices as have returned high yields in other cropping work of the Station. This includes, in addition to rotation, the use of barnyard manure and various commercial fertilizers. Results so far obtained indicate that irrigated soils of the Huntley Project are capable of much higher average production than is at present being obtained.

3. *Experiments with Sugar Beets*:

a. Commercial Fertilizers for Sugar Beets—This project was started in 1932 to determine the immediate and cumulative effect of commercial fertilizers for sugar beets. These fertilizers are treble superphosphate, ammonium sulphate, and potash. The project includes tests of these fertilizers applied at various rates alone, as well as in various combinations of the three.

b. Test of "Curly Top" Resistant Varieties—The occurrence of curly top disease of sugar beets in recent years has made it desirable to grow varieties that have been found to be resistant to this disease in other beet-growing areas. Four resistant vareties have been under test at the Station during the past three years to determine the variety best suited to local conditions.

4. *Crop Improvement Projects*:

a. Great Northern Beans—This project which is in cooperation with the Botany Department of the Montana Station has been under way during the past eight years. Several hundred individual plant selections have been tested and observed with reference to disease resistance, type and yield. Of the large number of selections that have been under test, it appears that at least four or five strains will be developed that will be much superior in yield and quality to the ordinary Great Northern beans that are at present grown in the area.

b. Hybrid Corn—A project was started in 1938 by the Agronomy Department of the Montana Station with the purpose of developing hybrid strains of corn adapted to local conditions. Some of the earlier maturing varieties of corn are already grown to some extent in the plains area of the State and it appears probable that the development of suitable hybrid seed will result in a favorable increase in yields and acreage of this crop.

5. Test of Miscellaneous Crops:

Tests were made in 1938 of various crops not commonly grown in the area but about which information is at times requested by local farmers. These tests included such crops as soy beans, sorghum, sudan gress, pyrethrum and safflower.

Experiments with Livestock

1. Dairy Cattle:

a. Feeding and Management—Experiments with dairy cattle that have been under way over a period of years deal, in addition to grazing tests of pasture crops, with comparative tests of the economy of production in which groups of cows are fed rations consisting of roughage alone, roughage and full feed of grain, and roughage with a limited amount of grain. Experiments to determine the value of alfalfa hay as a complete ration for dairy cows are also being conducted. Experiments in grazing irrigated pastures have included carrying capacity tests of various permanent pasture-grass mixtures and such crops as sweet clover and reed canary grass.

b. Breeding Experiments—The experiments in breeding deal mainly with an effort to establish a strain of cattle pure in their inheritance for high milk and butterfat production. It is the aim to accomplish this through the continued use of proved sires or sires that are known to transmit high production to their offspring. Sires are proved n cooperation with local dairymen who use Station sires in their herds and keep production records of their cows and the daughters of these sires.

2. Lamb Feeding:

A lamb feeding project in cooperation with the Animal Husbandry Department was resumed in 1938 after a lapse of four years. This project includes a test of the feeding value of locally grown feeds, including sugar beet by-products for the pen fattening of lambs. Feeding methods such as hand and self-feeding were also compared. Five lots of eighty lambs each were on feed to determine the comparative value of such feeds as long and cut alfalfa hay, dried beet pulp, wet beet pulp, beet tops and sugar beet molasses and oats.

Investigations in Dry-land Agriculture*

This phase of the work at the Huntley Branch Station involves experimental work with crops and livestock pertaining to dry farming, and investigations of factors influencing produc-

*The investigations in dry-land agriculture were begun at the Huntley Branch Station in 1912 by the Division of Dry-land Agriculture, U. S. D. A., cooperating with the Montana Agricultural Experiment Station.

tion. Most of the research work done in 1938 was a continuation of the long-time investigations begun in 1912. Because of the great variation in seasonal conditions from year to year, the results of these long-time experiments became more valuable, with the passing of the years, as a measurement of the possibilities and limitations of non-irrigated agriculture in the plains area of Montana.

Crop Rotations and Tillage Methods: The season of 1938 completed 27 years of work with an extensive series of crop rotations and tillage methods at this Station. In this work all of the common field crops have been grown continuously through long and short rotations in various crop sequences and by various tillage methods including kinds of plowing, disking, sub-soiling, listing, fallowing and green manuring. By comparing the data obtained from these experiments by years and by periods, it has been possible to determine the relative value of the various cropping practices.

Variety Tests of Crops: Throughout the period in which the dry-land investigations have been under way variety tests have been conducted from time to time with cereals, potatoes, seed, forage, pasture and garden crops. In recent years experiments have been conducted in methods of seeding crested wheatgrass in tilled and abandoned farm lands.

Pasturing Experiments with Swine: The results of twenty-four years are now available from pasturing experiments in which hogs have been raised from weanling age to marketable size and condition on a series of annual and perennial dry-land crops. From this experiment it has been possible to determine the relative feeding value, pasturing period, and the carrying capacity of the crops used in the test each year.

Soil Moisture Investigations: By an extensive program of weekly and periodic soil sampling, a seasonal record is kept of the amount, depth of penetration, storage and depletion of soil moisture as influenced by different tillage and cropping methods. The data thus obtained are correlated with crop behavior and soil condition in the various experiments.

Climatic Records: A complete system of meteorological records is kept at the Station, embracing all climatic factors influencing agricultural activities. A practical measurement of these factors is determined by their effect on crops and farming practices in these experiments.

Additional Investigations Needed: Additional problems and lines of work in dry-land agriculture which need attention at this

Station, but which have not been possible before due to limited finances, are a systematic and comprehensive program of variety testing of grains, seeds, forages and root crops to supplement the preliminary work already done; testing of new and unusual crops as they appear; additional experiments in the utilization of dry-land crops as feed and pasture for livestock; studies in plant breeding for increased yield and disease resistance; and comprehensive trials of new tillage implements and cultural methods.

NORTH MONTANA BRANCH STATION*

Havre, Montana
By
M. A. Bell

The research work in progress at the North Montana Branch Station near Havre is planned to assist in solving the problems of farmers and ranchers whose operations are influenced by the climatic and soil conditions which prevail in northern Montana, especially in those counties east of the Continental Divide and north of the Missouri River. The present program of research and fact-gathering observation deals with (1) crop production and soil improvement problems applying primarily to the farming and grazing of non-irrigated lands; (2) beef cattle breeding and management investigations; (3) shelter belts, ornamental plantings, and farm gardens; (4) general farm operations to produce dependable winter feed supplies, and (5) physical plant improvements which contribute to the efficiency of farm and ranch operation.

Agronomy Investigations

These investigations deal primarily with non-irrigated farming and range lands in north-central Montana and include studies of crop rotation systems; the influence of various methods of seedbed preparation; cereal improvement with special emphasis on adaptation; corn and forage breeding; and land rehabilitation.

N. M. 1—Dry-Land Crop Rotations and Tillage Methods:
The crops involved in these studies include spring wheat, winter wheat, spring rye, winter rye, oats, barley, corn, flax, brome grass, slender wheatgrass, crested wheatgrass,

*The North Montana Branch Station was established in 1913, through action of the Montana Legislature in accepting from the Federal Government a grant of 2000 acres of land, including the buildings, formerly the head-quarters of the Fort Assiniboine Military Reservation. Memoranda of Understanding and Cooperative Agreements between the Montana Station and the Bureau of Plant Industry, United States Department of Agriculture and the Indian Service of the United States Department of the Interior provide for cooperative research on some of the problems which are characteristic of north-central Montana, especially those counties north of the Missouri River.

alfalfa, peas and sweet clover. The objectives are:

1. To study the possibilities and limitations of dry-land crop rotation systems.
2. To determine the effect of the preceding crop upon the yield.
3. To study the influence of green manures and barnyard manures in maintaining soil fertility and crop yield.
4. To determine the effect of various methods of seed-bed preparation and tillage upon crop production.

N. M. 2—Soil Moisture Determinations:

Soil samples for the determination of moisture are taken from 42 field plots once each week during the growing season and at other times during the year in order

1. To study the removal of soil moisture by wheat and corn under different cultural practices.
2. To note the accumulation of moisture in fallow ground and annual variations in continuously cropped land.
3. To determine the significance of soil moisture fluctuations under different methods of cropping in relation to weather and yields.

N. M. 3—Forage Crop Rotations:

1. To obtain comparative forage yields of spring wheat, spring rye, barley, oats, peas and millet, grown on fallow and on spring plowed stubble.
2. To note the effect of these annual forages when cut for hay upon the yield of Marquis wheat on disking thereafter.

N. M. 5—Miscellaneous Tests:

Covering miscellaneous objectives and extraneous work, usually the outgrowth of some active project. Work of this kind is generally limited to one or two years duration, either being discontinued or outlined as a formal project.

N. M. 6 to 13—Variety Tests of Spring Wheat; Winter Wheat; Oats, Barley; Flax; Corn; Spring Rye; and Beans, Respectively:

1. To obtain comparative yields of varieties which are or might become commercially important in northern Montana when grown under practical conditions.
2. To record various agronomic data for each variety, including date of heading or flowering, date of maturity, height, test weight, protein content, and other quality indicators with notes as to disease resistance, hardiness, drouth resistance, and other factors which might tend to minimize or enhance the value of the variety for commercial production.
3. To recommend for replacing standard varieties when unquestionable superiority over a period of several years, preferably five or more, has been indicated.

N. M. 14—Methods of Fallow for Spring Wheat:

1. To obtain yield and other agronomic data for spring wheat grown on different methods of fallow preparation.
2. To study the effect of time of plowing for fallow upon yield.
3. To note the influence of stubble cultivation before plowing.
4. To compare plowless fallow with plowed fallow.
5. To study rotated plowless and plowed fallow systems.

N. M. 15—Preparing Fallow for Spring Cereals Sown on Different Dates:

1. To study the effect of date of seeding upon the yield of spring wheat, oats, barley and rye, sown on fallow, and to obtain various agronomic data of practical significance.
2. To obtain information relative to the control of Russian thistles and other weeds by cultivation of fallow previous to seeding.
3. To study the effect of the application of phosphate fertilizer upon the yield, quality, and agronomic performance of certain plats in this series, involving the four crops mentioned above.

N. M. 17—Comparing the Furrow Drill and Ordinary Drill in a Date of Seeding Test of Winter Wheat on Fallow:

1. To study comparative winter survivals and yields obtained by using a furrow drill and ordinary drill for planting winter wheat on fallow.
2. To obtain information relative to the effect of time of planting upon survival and yield.

N. M. 18—Date of Planting Corn:

1. To obtain field cured fodder and air dried fodder weights of corn planted on different dates.
2. To obtain other agronomic information such as relative maturity at harvest, height, stands, and other pertinent factors.

N. M. 19—Winter-Hardiness Nursery:

To obtain information relative to winter hardiness and yields of hybrids, selections and varieties of winter wheat grown in nursery rows for the purpose of finding a better commercial hardy variety of winter wheat for the plains area of northern Montana.

N. M. 20—Breeding Improved Spring Wheats for Northern Montana:

1. To develop by introduction, hybridization, and selection, better commerical varieties of spring wheat for northern Montana.

2. To study various factors which indicate yield and quality as a basis for subsequent selection work.

N. M. 21—Corn, Sunflower, and Safflower in Rotation:

1. To obtain yields of corn, sunflowers and safflower under dry-land conditions.
2. To study the effect of safflower as a previous crop in a rotation system.
3. To compare yields of wheat on disking after these crops.

N. M. 22—Climatic Data:

1. To record daily climatic information, including precipitation; wind movement; maximum, minimum, and air temperatures; summer-time daily evaporation, psychrometer reading, wind direction, and state of sky.
2. To study various relations between climatic factors, soil moisture, and crop production which might have a significant bearing upon land use policy.

Other agronomic projects which are producing information of distinct value to farmers in north-central Montana are: 24—Breeding improved oats for northern Montana; 26—Spring rye versus winter rye for grain and forage; 27—The protein content of wheat and other grains; 28—Renovation methods for native sod; 44—Alfalfa varieties; 45—Alfalfa in cultivated rows; 47—Alfalfa nursery; 49—Small grains for hay; 50—Date and method of seeding grasses; 52—Date of seeding oats and millet for hay; 53—Dakota amber sorgo, Sudan grass and corn compared in a date-of-planting project; 54—Sweet clover sown with and without a nurse crop in a date-of-planting test; 55—Comparative yields of sweet clover sown close-drilled, and in rows; 56—Sweet clover varieties; 58—Corn breeding; 60—Breeding improved barleys for northern Montana; 62—Relationships between experimental crop yields and weather; and 66—Grass nursery.

Animal Husbandry Investigations

Land and other facilities available at the Station combined with a long-time lease in the Bear Paw Mountains grazed under a cooperative agreement with the Indian Service, U. S. Department of The Interior, permits some investigations with beef cattle of general interest to stockmen in north-central Montana. The North Montana Branch Station maintains a breeding herd of 150 high-grade Hereford cows, which with the offspring provide an opportunity for the investigation of some of the pressing problems confronting cattlemen in northern Montana.

N. M. 63—Large Versus Small Type Sires for Grade Hereford Cattle:

1. To determine whether the progeny of large, heavy-boned,

beef bulls will produce as desirable grade Hereford cattle as the progeny of small, earlier maturing, more compact bulls.

2. To study the cumulative effect of the continued use of large and small type bulls on the calves, heifers, and cows resulting therefrom.

N. M. 64—Limited Versus Full Winter Feeding of Roughages to Calves, Yearlings, and Two-Year-Old Heifers:

1. To compare the effect of liberal and limited winter roughage rations upon the subsequent summer gains of calves, yearlings, and two-year-old heifers.
2. To study the results of limited and full feeding of roughage to calves, yearlings and two-year-olds with reference to its effect upon mature breeding cows.
3. To determine if the different planes of nutrition will have any influence upon the birth and weaning weights or other differences in calves dropped by two-year-old heifers.
4. To compare the cost of the two planes of winter feeding and other economic factors in connection with the project as a whole.

N. M. 66—Methods of Wintering Grade Hereford Beef Cows:

1. To determine the relative feeding value for winter maintenance of locally available roughages and effect upon calving problems, and birth and weaning weights of calves.
2. To obtain data on yearly feeding requirements other than pasture for maintaining beef cows.
3. To secure information on various problems concerned with the general management of the range breeding herd.

N. M. 67—Summer Grazing on the Bear Paw Mountain Lease:

1. To study management problems in connection with handling several breeding herds involving pasture arrangement, the use of electric fencing units and other practical points.
2. To study various problems which might arise in the efficient utilization of this particular range.
3. To observe the effect of deferred grazing upon the availability of forage through comparisons shown by protected areas supplemented by other botanical observations and notes.

General Farming Tests and Observations

This division of the work at the North Montana Branch Station is concerned chiefly with the growing of feed, grain, hay, and seed used in connection with the livestock investigations. Farming operations are conducted both under dry-land and irrigated conditions. The non-irrigated part of the farm is devoted principally to the production of grain hay raised on summer fallow. Strip crop-

ping to prevent wind erosion is being practiced along with modern summer fallow methods designed to store a maximum amount of seasonal moisture with a minimum amount of tillage Both plowed and plowless fallow are used, weed control operations being conducted so as to maintain a cloddy mulch.

The irrigated lands are devoted to the production of alfalfa for hay. Part is irrigated by the border dike system while a small acreage along the creek bottom is sub-irrigated. During the past two years W. P. A. projects have assisted in clearing 30 acres of sub-irrigated land for alfalfa hay production. The principal objectives of *N. M. 61—Farm Fields* are:

1. To produce hay and grain for livestock experimental work.
2. To try out those practices and adapted varieties under field conditions which have given best experimental results.
3. To study practical farming problems wherever they arise in connection with these general farming operations.

Horticulture Studies

Studies with the production of horticultural crops, shelter belts, and ornamental plantings, and farm gardens, are in progress. The work with shelter belts and ornamentals deals mostly with the testing of species, and methods of planting and management after the plantings have become established. The vegetable investigations are limited to potatoes on the dry-land and farm gardens under irrigation.

Physical Plant Development

The responsibility for upkeep of buildngs and grounds, water systems, roads, fences, repairs to machinery, cars, trucks, and other equipment used by the Station is assigned to the Physical Plant Department This department occasionally contributes to the efficiency of the general research program through the construction of special equipment. During the past three years, through the assistance of the Works Progress Administration, a duplex dwelling house has been remodelled, a machine shed and shop built out of salvage materials, a hay barn erected in connection with the beef cattle feeding shed; the livestock handling corrals completely revised and extended, and the beef cattle barn rearranged to permit the feeding of calves in individual stalls in record-of-performance studies.

UNITED STATES RANGE LIVESTOCK EXPERIMENT STATION*

Miles City, Montana
By
J. R. Quesenberry

The general functions of the staff at the United States Range Livestock Experiment Station consist chiefly of research in breeding and management, feeding and nutrition of beef cattle, horses, swine and sheep. Since the Montana Agricultural Experiment Station owns and maintains approximately 675 to 725 head of Hereford cattle of excellent quality at the Range Station, primary emphasis is placed on the investigation of the problems of handling beef cattle under range conditions. The Montana Station also owns and maintains 222 head of horses, about equally divided between the draft and saddle types, as its contribution to the horse investigations.

Search for superior types in beef cattle, horses, and swine is being conducted as a means of increasing efficiency and economy of production. Range utilization studies are carried on with cattle and sheep to determine the most economical use of the range. The influence of nutrition and methods of feeding, as well as breeding, on the animal products is being studied.

Active Projects and Their Objectives

Beef Cattle Husbandry Investigations—have as their objectives:

1. The establishment of true breeding strains of Hereford cattle, particularly adapted to the western range country having the following characteristics:
   (a) High fertility
   (b) Capacity to make gains rapidly and economically
   (c) Desirable type and conformation for the range country
   (d) High dressing percentage of edible beef of superior qualities.
2. The development of strains of inbred Hereford cattle that, because of their greater homozygosity, should prove superior for outcrossing and cross-breeding, and to compare the performance of these inbred strains with crossbred cattle having a maximum degree of heterozygosity.
3. The utilization of the range belonging to the Station which

*The U. S. Range Livestock Experiment Station, established in 1925, on the site of the Fort Keough Military Reservation, is owned by the United States. Memoranda of Understanding and Cooperative Agreements between the Bureau of Animal Industry and the Forest Service of the United States Department of Agriculture and the Montana Agricultural Experiment Station provide for cooperative research in range livestock investigations, the results of which apply not only to the short grass range areas of eastern Montana, but to the grazing areas generally in the Northern Great Plains.

has been set aside for beef cattle husbandry experiments, and to cooperate with the State and Federal specialists in grazing and vegetative studies in the determination of utilization standards and carrying capacity of short grass ranges in the Northern Great Plains region.

4. The determination of the effect on the subsequent growth and development of suckling calves, of summer treatment with their dams on three different intensities of grazing.
5. The determination of the value of dried beet pulp as a preventative of bloat and other feed lot disorders when added to the alfalfa-corn and alfalfa-barley rations fed to fattening calves.

Horse Husbandry Investigations—have as their objectives:

1. By the use of horses of Nonius, Belgian and Thoroughbred breeding to produce and fix types of horses especially suited for western range and farm conditions and for military uses.
2. To determine by a study on physiology of reproduction with mares and stallions methods of increasing the percentage of foals.

Cooperative Range Management and Range Rehabilitàtion Research—

1. To determine the best methods of range rehabilitation and better balanced management and utilization practices for native ranges common to the Northern Great Plains region. This work involves the grazing of cattle on three intensities of grazing and sheep on five degrees of utilization.
2. To determine the reaction of the cattle and sheep and range vegetation in response to variation in treatment.
3. To develop cheap methods of artificial range reseeding and to determine season, rate of seeding, depth of cover, soil conditions, etc., that yield best returns, the most valuable species and their relative grazing value at different seasons of the year and for the different classes of livestock in comparison with adjacent native range.
4. To determine effective methods of conserving flood waters by a system of check dams, and contour dikes and furrows, and the influence of water thus conserved on the various kinds of native range vegetation.

Swine Husbandry Investigations have been chiefly concerned with a study of genetics, economy of production and quality of carcasses of crosses and various back crosses of the Landrace and Hampshire breeds of swine in comparison with the parent breeds. (It is the purpose of this study to combine genetically the best traits of each of these breeds into one strain.)

GENERAL INFORMATION

COOPERATIVE RELATIONSHIPS

Research cannot serve agriculture economically nor efficiently unless the research program presents a coordinated attack on the problems to be solved. Such an approach to the solution of the problems of agriculture is possible only through effective cooperation of all agencies concerned.

The progress made by Montana Agricultural Experiment Station, including its branches, has been due in a large measure (1) to the fine spirit of cooperation within the organization, both between individuals within a single department and between departments; and (2) to the friendly and effective cooperation between individuals and departments within this Station and the numerous Federal, State, and private agencies. During the year, cooperative relationships have been maintained through both formal and informal agreements with a large number of agencies, whereby agricultural research in Montana receives the benefits of financial aid and technical assistance above what is possible by direct legislative appropriations.

Among the agencies which cooperate with the Montana Agricultural Experiment Station are the United States Department of Agriculture, the United States Department of Interior, the Farm Credit Administration, Tennessee Valley Authority, Work Projects Administration, National Youth Administration, National Resources Committee, Montana State Department of Agriculture, Labor and Industry; Montana Livestock Sanitary Board, Anaconda Copper Mining Company, and the Agricultural Experiment Stations of nearby states. Among the various Divisions and Bureaus of the United States Department of Agriculture which cooperate with the Montana Station are included the Agricultural Adjustment Administration, the Farm Security Administration, the Soil Conservation Service, the Forest Service, and the Bureaus of Agricultural Economics, Animal Industry, Chemistry and Soils, Dairy Industry, Entomology and Plant Quarantine, Plant Industry, and the Weather Bureau.

CHANGES IN STATION STAFF

Resignations: Resignations from the research staff include M. H. Saunderson and P. S. Eckert, Department of Agricultural Economics; E. J. Wellhausen, Department of Agronomy; D. W. Chittenden, Department of Animal Husbandry; J. R. Green and

S. B. Speck, Department of Chemistry and Meteorology; Ruth S. Haggerty, Department of Home Economics; and Anne Nechanicky, Veterinary Research Laboratory.

New Appointments: New appointments to the research staff include O. A. Parsons and H. G. Halcrow, Department of Agricultural Economics; A. M. Schlehuber, Department of Agronomy; R. T. Clark, S. K. McIlvanie* and John Nye*, Department of Animal Husbandry; W. P. Willis and D. R. McCormick, Department of Chemistry and Meteorology; A. J. Hill**, Department of Irrigation and Drainage; and Kay Lyon, Veterinary Research Laboratory.

New Department: On July 1, 1938, the Department of Dairy Industry was created by combining the work with Dairy Production (formerly included in the Department of Animal Husbandry) and the work in Dairy Manufacturing (formerly operated only as a teaching department).

The new Department of Dairy Industry in the Agricultural Experiment Station is headed by Dr. J. A. Nelson, formerly head of the dairy manufacturing instruction in Montana State College, and he is assisted by J. O. Tretsven as Professor in charge of Dairy Production.

*Temporary appointments.
**Assistant in rural electrification.

FINANCIAL SUMMARY

EXPENDITURES OF THE MONTANA AGRICULTURAL EXPERIMENT STATION FOR THE YEAR ENDING JUNE 30, 1938

	Hatch	Adams	Purnell	Blankhead Jones	State and Others*
Salaries	$ 7,475.16	$12,488.94	$41,121.50	$ 8,297.29	$55,456.62
Labor	3,096.34	534.95	11,043.27	3,022.50	14,167.47
Stationery and Office	1,034.12	5.88	24.56	——	1,943.59
Scientific, Consumable	4.89	458.47	895.94	109.32	949.86
Feeding Stuffs	327.83	——	847.00	9.00	14,044.45
Fertilizers	45.00	——	5.75	——	213.73
Sundry	99.05	54.29	500.13	29.63	9,203.94
Communication Service	336.43	——	26.42	10.86	1,133.47
Travel Expenses	261.77	488.09	2,003.39	119.37	2,669.99
Transportation of Things	10.72	4.30	71.30	2.94	625.30
Publications	1,412.99	——	1,526.32	——	3,138.99
Heat, Light, Water, Power	576.67	——	123.59	——	2,910.75
Contingent Expenses	14.43	21.90	31.04	——	95.00
Furniture, Furnishings, Fixtures	——	20.41	167.46	22.00	625.35
Library	205.90	12.63	35.00	——	248.43
Scientifc Equipment	55.15	857.63	450.87	3.25	201.97
Tools, Machinery, Appliances	43.55	44.85	988.32	1.21	5,810.48
Livestock	——	——	12.50	——	1,657.50
Building and Land	——	7.66	125.64	——	2,491.12
Totals	$15,000.00	$15,000.00	$60,000.00	$11,627.37	$117,588.01

*This fund includes the following:

State Appropriations for Home Station	$44,003.41
For Grain Laboratory and Branch Stations	26,922.21
Income from Sales	65,523.42

ORGANIZATION OF THE EXPERIMENT STATION[1]

Roy E. Ayers, Governor		Ex-officio, President	
Harrison J. Freebourn, Attorney General		Ex-officio	
Ruth Reardon, Supt. of Public Instruction		Ex-officio, Secretary	
Carl D. Borton	(1939)	George S. Gosman	(1941)
Reyn Leedom	(1939)	Mrs. Mamie Nance	(1941)
E. C. Carruth	(1940)	Wallace Brennan	(1942)
W. S. Davidson	(1940)	Emmett J. Riley	(1942)

A. L. STRAND, Ph. D.—President
CLYDE MCKEE, M. S.—Director

AGRICULTURE ECONOMICS

E. A. STARCH, B. S., Head of Dept.
R. R. RENNE, Ph. D., Agrl. Economist.
P. L. SLAGSVOLD, Ph. D., Agrl. Economist.
C. F. KRAENZEL, Ph. D., Asst. Agrl. Economist.
O. A. PARSONS, A. B., Asst. in Agrl. Economics.
H. G. HALCROW, M. S., Instructor.

AGRONOMY

A. H. POST, M. S., Head of Dept.
R. H. BAMBERG[2], Ph. D., Assoc. Agron.
L. F. GIESEKER, M. S., Assoc. Agron.
A. M. SCHLEHUBER, Ph. D., Assoc. Agron.
F. K. NUNNS, M. S. Asst. Agron.
L. P. REITZ,[2] M. S., Asst. Agron.
WM. B. NELSON, B. S. Asst. in Agron.

ANIMAL HUSBANDRY

R. T. CLARK, Ph. D., Head of Dept.
E. R. McCALL, M. S., Assoc. An. Husb.
S. K. McILVANIE, B. S., Asst. in An. Husb.
JOHN NYE, B. S., Asst. in An. Husb.

BOTANY AND BACTERIOLOGY

H. E. MORRIS, M. S., Head of Dept.
M. M. AFANASIEV, Ph. D., Asst. Botanist

CHEMISTRY AND METEOROLOGY

EDMUND BURKE, B. S., Head of Dept.
F. T. DONALDSON, Ph. D., Asst. Chem.
W. P. WILLIS, JR., B. S., Asst. in Chem.
D. R. McCORMICK, B. S., Asst. in Chem.

DAIRY INDUSTRY

J. A. NELSON, Ph. D., Head of Dept.
J. O. TRETSVEN, M. S., Dairy Husb.

ENTOMOLOGY

H. B. MILLS, Ph. D., Head of Dept.
J. H. PEPPER, M. S., Asst. Ent.
D. J. PLETSCH, M. S., Asst. Ent.

GRAIN LABORATORY

A. H. POST, M. S., Director
W. O. WHITCOMB, M. S., Supt.
W. D. HAY, M. S., Seed Analyst.

HOME ECONOMICS

JESSIE E. RICHARDSON, Ph. D., Head.
HELEN L. MAYFIELD, M. S., Asst. H. Economist.

HORTICULTURE

F. M. HARRINGTON, M. S., Head.
V. E. IVERSON, M. S. Asst. Hort.

IRRIGATION AND DRAINAGE

O. W. MONSON, M. S., Head of Dept.
A. J. HILL, M. S., Asst. in Rural Electrification.

VETERINARY RESEARCH

HADLEIGH MARSH, B. S., D. V. M., Head.
HOWARD WELCH, B. S., D. V. M., Vet.
E. A. TUNNICLIFF, M. S., D. V. M., Assoc. Vet.
KAY LYON, M. S., Asst. in Vet. Res.

LIBRARY AND PUBLICATIONS

F. B. LINFIELD, B. S. A., Director Emeritus and Head
MARGARET DEWEY, B. S., Bulletin Ed.

MISCELLANEOUS

LOUIS G. TRUE, B. S., Ag. Publicity.
LOUISE EAGER, B. S., Sec'y to Director.
BERNARD COPPING, B. S., Asst. to Secretary and Treasurer.

BRANCH STATIONS

Horticulture Branch Station ..... **Corvallis**
W. E. Pollinger, Superintendent

Huntley Branch Station[2] ..... **Huntley**
Dan Hansen, Superintendent
A. E. Seamans, B. S., Dry Farming — D. V. Kopland, B. S., Dairying

Judith Basin Branch Station[2] ..... **Moccasin**
R. M. Williams, B. S., Superintendent

North Montana Branch Station[2] ..... **Havre**
M. A. Bell, M. S., Superintendent

U. S. Range Livestock Experiment Station[2] ..... **Miles City**
J. R. Quesenberry, M. S., Superintendent
A. L. Baker, B. S., Cattle — E. B. Osborn, B. S., D. V. M., Horses
R. E. Hutton, B. S., Swine

[1]Organization as of November 30, 1938.
[2]Cooperating with the United States Department of Agriculture.

INDEX

Contents *Page*

FOREWORD 2

FOUNDATION AND PLAN OF THE MONTANA AGRICULTURAL EXPERIMENT STATION 3

DEPARTMENT AND ACTIVITIES AT BOZEMAN 4

Department of Agricultural Economics 4

1. Functions of the Department 4

2. Active Projects and Their Objectives 5

Department of Agronomy 11

Department of Animal Husbandry 16

Department of Botany and Bacteriology 20

Department of Chemistry and Meteorology 21

Department of Dairy Industry 23

Department of Entomology 24

Department of Home Economics 26

Department of Horticulture 28

Department of Irrigation and Drainage 31

Department of Library and Publications 33

Montana Grain Inspection Laboratory 36

Veterinary Research Laboratory 38

BRANCHES OF THE MONTANA AGRICULTURAL EXPERIMENT STATION 40

Judith Basin Branch Station 40

Horticulture Branch Station 43

Huntley Branch Station 47

North Montana Branch Station 51

United States Range Livestock Experiment Station 57

GENERAL INFORMATION 59

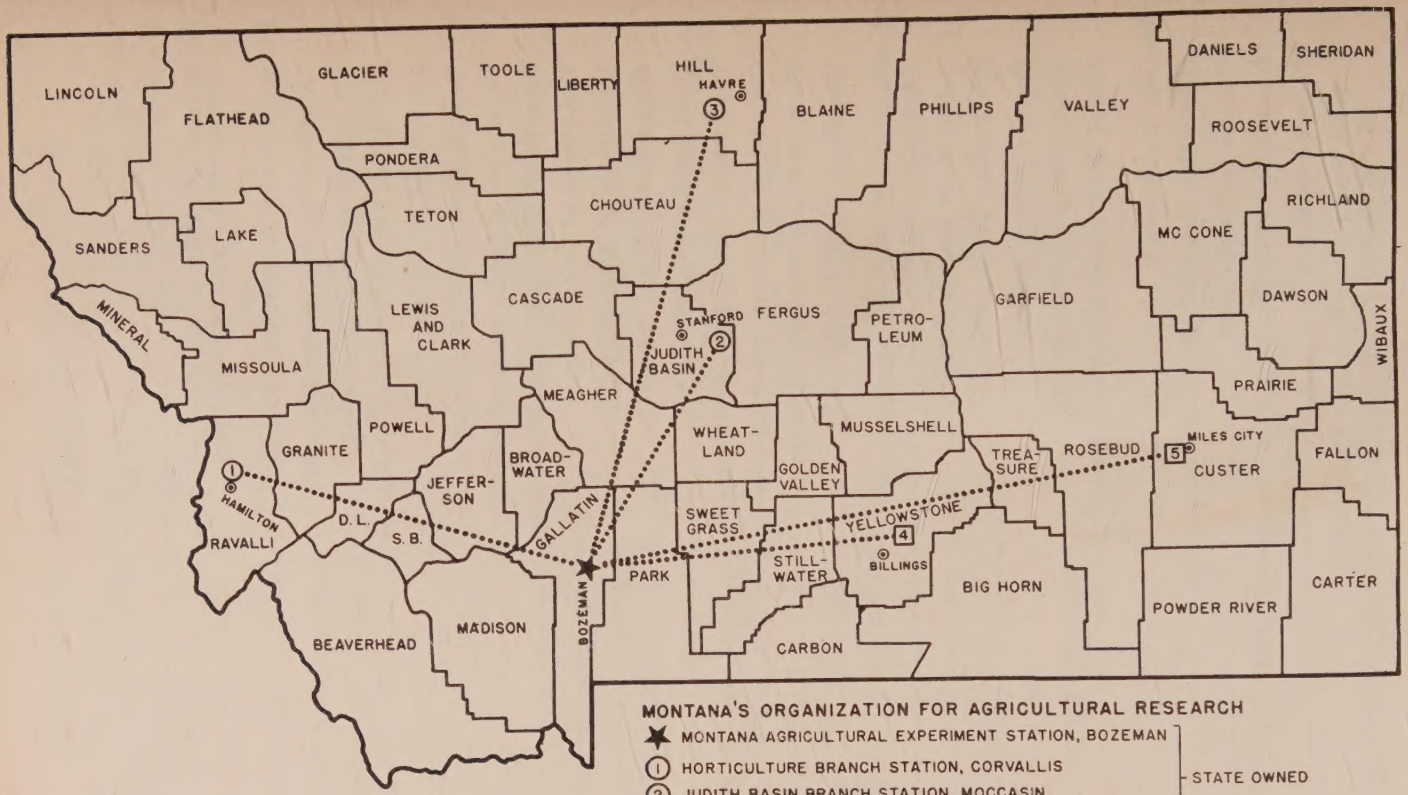
Cooperative Relationships 59

Changes in Station Staff 59

Organization of Station Staff as of November 30, 1938 60

Financial Summary 61

Graphic Illustration—Montana's Organization for Agricultural Research 64



MONTANA'S ORGANIZATION FOR AGRICULTURAL RESEARCH

- ★ MONTANA AGRICULTURAL EXPERIMENT STATION, BOZEMAN
- (1) HORTICULTURE BRANCH STATION, CORVALLIS
- (2) JUDITH BASIN BRANCH STATION, MOCCASIN
- (3) NORTH MONTANA BRANCH STATION, HAVRE

STATE OWNED

- [4] HUNTLEY BRANCH STATION, HUNTLEY
- [5] U.S. RANGE LIVESTOCK EXPERIMENT STATION, MILES CITY

FEDERAL OWNED